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ABSTRACT

Since it became known in 1979 that the Arkansas Power and Light Company was going to build a large electricity generating plant near Hampton and that there would be a lignite mining operation established there to support the power plant, the Warren public schools have been preparing to meet the impact on the schools. Because it was assumed that the growth of these new industries would create a demand for many more technically trained workers from the communities in the area, research was conducted to develop a curriculum to train them. This report includes background information and suggested curriculum to train workers in three broad areas: industrial electricity, metallurgy, and heavy equipment operation. For each of these areas, information is provided on types of jobs in the field, skills required for each occupation, suggested course content for training workers in these fields, and suggested resources for developing curriculum units. The report also contains an analysis of the projected impact of the industrial development on the schools of the area, and what role each school district and type of school should play. A bibliography of materials suggested as resources for developing curriculum or for use as instructional materials is included in the report. (KC)

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LIGNITE RESEARCH PROJECT

Warren Area Vo-Tech Center
Warren, Arkansas

Phase I Completed
Phase II Completed
Phase III Completed

Submitted By:

BEST COPY AVAILABLE

Fred Robinson, Director
Area Vo-Tech Center

January 1, 1983

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Introduction to Report

The schools receiving the greatest impact due to the Sparta lignite mine in Hampton would be the secondary schools Warren, Monticello, Camden and the post-secondary schools Great Rivers in McGhee, Oil Belt in El Dorado, Forest Echoes in Crossett, and Red River in Hope. The research for this project was accomplished within an area served by these schools. The two exceptions to this area are AP&L, who will be the owner and operator, and Shell Oil Corporation, who will be in charge of construction and mining.

During the course of this project, AP&L postponed the Sparta mine for the second and third time (see page 144). To allow pessimism to lose sight of goals is counterproductive to the whole picture because more is at stake than just an area of Arkansas.

Currently the American economy is in a period of change. As the alteration takes place, industrial electricians will become much more important, because it is only a matter of time until electricity runs everything. The advent of computers and industrial robotics is making an even greater push on the technicians. Highly skilled metal workers will be needed to make these machines and weld the various components, including plastics, into a productive unit. Heavy equipment operators and construction workers will be needed to build the plants. It is imparative that the vocational schools stay abreast to developments in their area as well as industries as a whole for no one knows when a high technological plant may develop in their area.

The Arkansas Department of Education through its vocational-technical programs is in a position to make a substantial contribution to the well-

being and future of the citizens of this state. It it is to prepare its citizens for tomorrow's jobs, it must maintain the pace of industry if not lead the way.

The topics of this report are industrial electricity, metallurgy, and heavy equipment operation. Each topic is independent of the other topics.

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PROJECT NUMBER:

PROJECT TITLE: Mining and Power Production Technology Curriculum Research for Southeast Arkansas Area Impacted by New Lignite Industry

PROJECT SUBTITLE: An Approach to Industrial Electricity: Graduated via Germane Occupations

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PREFACE:

With the advance of moderization of industry, the area of maintenance has broadened to include many areas beyond the scope of the carpenter or mechanic. Technology has expanded the work load of the maintenance person to encompass areas of electricity/electronics that has grown exponentially since its initial use in industry. The field of maintenance was as broad as any one person's knowledge can reasonably withhold. While the northern and far western states have been using specialized maintenance persons for many years, the south has continued to expect that its maintenance be handled by as few non-specialized maintenance people as possible. However, the recent growth of the 'sun belt' and the rush to meet foreign competition through modernization is currently stressing the general maintenance people beyond their limit. Although to a large degree there will always be a need for general maintenance, the advent of technology is separating this field into highly specialized devisions.

This brings up the question, "Where does industry get these specialized maintenance people?" To a large extent, these people have gotten their initial training from the armed service and on the job training. Although on the job training covers specific education about the particular manufactures in question that is essential to any new employee, the necessity of initial training by the military should not be manditory. Therefore, this report presents the student with an option to one area of specialized maintenance training.

The volume of material at the beginning of a research project is tremendous. The researcher must weed through publication listings as well as the immediate library to avoid duplication and be able to obtain pertinent material. While waiting on ordered material a person must begin a thorough study of what is being used currently, what has been planned, if any, and a brief view of the libraries publications.

An advantage in this situation has been the course already in progress with the utilization of the instructor, who has given much advice, constructive criticism, and an understanding of a student's time element.

The scope of the field of electricity is extremely broad. A person had better be aware of this when ordering material from various authors, because once the basis of electricity are covered, different authors generally take to different tangents which can possibly go beyond the texts title. An excellent example is Fundamentals of Electricity by Robert G. Seippel, who covers computer technology in one of the closing chapters. This material is important; but it is a part of electronics not electricity.

Another area that one must consider is the level of a publication. Some authors tend to write clearly without the undue technical coverage while others are unable to cover the same material without necessitating complete mathematical detail.

As the research continued, the projects direction became more constructive with the introduction to a library in Illinois. The East Central Network and Illinois Curriculum Network is a loan free library designed for the benefit of research and curriculum improvement.

From this source the project was able to obtain a copy of Electricity Occupations Curriculum Guide, July, 1975, developed through the Illinois office of education in conjunction with representatives from industry. Using this material as a significant source the research remained to allow for the variation of the S.E. Arkansas area's requirements and find the actual curriculum material.

The findings from meetings with industries varied greatly. Some of the firms that would benefit most were the least interested to contribute their time and suggestion. In other cases there seemed to be a fear of future competition. Even so, a few cases did offer encouragement and suggestions. This report does contain the material they specifically requested.

Electricity is a technical subject. A person does not go far into the material before algebra is encountered. Generally, Ohm's Law is the first formula to be encountered. Although it is very simple, a student must have some understanding of algebra to comprehend the relationship the various elements of the formula can take. Since this formula is but a building block for many other formulas and possibly the simplest, a student should have an understanding of algebra to complete this course.

Observations that have been made about the various industrial contacts in this area point out the diversification among manufacturers. Therefore, it seems that the most logical conclusion is that the material within this report cover all the material suggested by the Guide, leaving the final variation of material for an area to the instructor, his advisory board, and the school director.

A flow chart was constructed from the Guide's occupational/educational blocks cross reference chart (see page 17). The flow chart tended to express several significant contributions. A course designed by it would give several occupational drop-offs along the way to an industrial electrician. Of course, this has many benefits to a time pressed student who may not be able to finish the entire course and provides a place to re-start later.

Considering the extent of the consortium publications the flow chart expressed a means to organize already published material, in most cases, to arrive at a competency guide. The major draw backs are: several areas have no published material by the consortium at this time and several other areas were written for other occupations that will have to be edited. Even so, this compilation of consortium material does give an instructor a course guide that the teacher could fill in the missing pieces until the consortium can manage to publish the requested material. Plus the material would be in the Mid-America Vocational Curriculum Consortium format which is the approved format for all new curriculum for Arkansas.

INDUSTRIAL OCCUPATIONS

The industrial contacts showed a distinct interest in quality students for employment now. They expressed a need for skilled technicians that seemed critical enough to warrant the handicap of incompletely trained personnel. This program takes from two to four years to complete. The need for industrial electricians is now and will continue to increase.

Taken into consideration when the quantity of material that a student must cover in the field of industrial electricity, it is entirely through the unique design of this program that a student obtains any other field of coverage than just an industrial electrician or trainee. In all the guides and material that has been uncovered, this is the only program that offers a student occupational steps toward an industrial electrician.

This curriculum design presents a secondary student three occupational choices: residential, agricultural, and industrial construction electricians. After graduation a student could enter any one of these occupations with only the normal on the job training.

From the post-secondary, a student could choose from four occupational areas: commercial, locomotive, and industrial electricians and electrical technician. As can be seen from the course outline, all of these areas are presented with curriculum. It is left to the instructor, the school's director, and the board of advisors for the course to decide what occupations to cover.

ENTRY LEVEL SKILLS

To determine the entry level skills that are required for the seven occupations that this curriculum is designed to cover, one must refer to the flow chart (page 16) titled "Entry Level Skills". All occupations begin at start and flow through the chart as each is indicated. The end of an occupation is when that title appears to the left side of the outline.

INSTRUCTIONAL PROGRAMS

A way to structure the course would be to begin with the Mid-America Vocational consortium's Residential Wiring with inclusions from Air Conditioning & Refrigeration Book I and II, Auto Mechanics, Mechanical Drafting, Power Lineman Tech. and Basic Electronics Book I and II. A few topics presented in the outline are not covered or are insufficiently covered by the curriculum material and must be addressed by the instructor.

To obtain an understanding of the thoroughness of the curriculum material that is being presented, a comparison between the flow chart drawn from the Electricity Occupational Curriculum Guide, July, 1975, by the Illinois Department of Education and the table of contents of this arrangement follows. Refer to flow charts titled "Illinois Guide", page 17 and "Compiled Curriculum", pages 18 to 20.

The Guide has forty-two areas of education toward an electrical technician that has been arranged into thirty-five sections. These units, along with the prepared units, give a thorough coverage of the material requested by the guide.

By comparing the two charts, it can be seen that the one difference between the two is that the material gives the student an occupational introduction at the beginning of new material following an employment exit point. These give the student an idea of what to expect from each field.

The material in section one presents safety in three units: General Safety, Electrical Safety, and Treatment of Electric Shock Victims, that was written by Leigh Hargis. Considering that safety is as broad an area as it is, this presents a good coverage of the subject, even though it would have been better if adequate information could have been found covering safety in using above 500 volts.

The second section covers tools: Pouch Tools, Hand Tools, and Specialty Tools. This presentation gives a student a good start in dealing with the tools of this trade. The last unit in the section is hot-iron soldering. This was placed here due to the fact that it is a trade tool and the safest means of joining metals by heat.

The third section presents Basic Theory as well as part of Wiring I, in reference to the Guide, and Instruments and Measurements I. Presenting the material in this manner allows the student a practical application of the basic theory.

"Using Trade Information" covers the National Electrical Code as well as Drawings & Specs. Electrical. The unit on the National Electrical Code does need to be updated to better cover the 1981 revision. Wiring Diagrams and Blueprints & Specifications present Electrical Drawings & Specs. in an excellent manner.

A unit on batteries needs to be covered for as homes and businesses become more self-sufficient the need for energy storage devices will increase. This unit should cover how to charge, maintain, and replace batteries as well as how to connect them in series and parallel. Also, the student should be able to check battery charging equipment. The section from Auto-Mechanics II has been placed here as the core to this material. The types of batteries is all that will need added material.

Book II starts with an introduction to the agricultural electrician.

The second section of Book II covers the functions of four components that may be encountered by the electrician. These are thermostats, relays, protection devices, and capacitors.

At this stage of the curriculum, the requirement for algebra should become effective as either a prerequisite or a co-requisite.

The four units of "Power and its Transfer" cover thoroughly Basic Circuit Configuration and Drawings & Specs. Mechanical. The unit on Conductors and Insulators covers material that the industrial electrician at Masonite specifically requested. The unit on Power Transmission covers Drawings & Specs. Mechanical, which show power transfer via of pulleys, gears, etc.

The section of Motors I is a good introduction to AC Motors & Generators. It presents an introduction and four different types of motors: Split-phase, shaded-pole, capacitor and three-phase motors.

Plus, this section needs to have a unit on catalog technical publications, which should cover how to find, organize, file and use technical electronic catalogs.

The section on Lubricants and Cleaners is not written. A general coverage of cleaners followed by the particular usage in the electrical/electronic field would express the need of this subject. Of course, lubricants could be treated similarly. Sources for this information are the encyclopedia, Exxon's publication "Principles of Lubrication", the American Association for Vocational Instructional Material's publication "Fuels & Lubricants", and the Plant Engineering Training System's unit on lubrication.

The section on Basic Equipment and Procedures covers equipment, wiring methods and load centers. These in essence, cover component identification, the remainder of Wiring I, and part of Wiring II.

Wiring Residential Circuits covers Wiring II, switches, fuses, breakers, and finish wiring as well as other material the residential electrician will need to know.

The section on Existing Dwellings is comparable to Rewire and Modify which the locomotive electrician and the electrical technician may perfer to skip.

The last section in Book I, Related Information, covers troubleshooting, which is needed by all the occupations. And the remainder of this section, Customer Service, Take-Off and Estimate, and Applying for a Job, is material needed by the residential electrician. These last three sections complete the residential electrician's education but may be beneficial to the other occupations.

A section on controls needs to be written. A thorough introduction to controls with several practical application activities should be sufficient. Possible sources are: Electrical Maintenance, Plant Engineering Training Systems, Unit 6 DC Equipment & Controls and Unit 9, AC Control Equipment, and Electric Motor Control by Walter Alerich.

"Ropes and Rigging" is a section for the agricultural electrician. It describes methods and procedures for dealing with heavy objects.

The welding section is for the agricultural electrician and the industrial electrician. All phases of torch heat are covered from brazing to welding. Electric welding is also covered.

An introduction to industrial construction electrician is now in order as the agricultural electrician completes the course.

The section on Transformers and Capacitors is not complete. While transformers are covered by the various units pretty well, no information has become available on large industrial capacitors.

The section on Motors II has only an introduction to DC Motors. It needs to have some units covering several DC Motors.

The completion of Book II is with Electronic Circuit Fundamentals from Basic Electronics. At this point the students have three areas of knowledge: residential, agricultural, and industrial construction electricity.

This is a good place for the secondary instructor to move from this guide to some trainers. The trainers are published by Electronic Training Materials, Inc. operating from Birmingham, Alabama. The three trainers are Basic Electricity, Basic Electronics, and Industrial Electronics. To keep costs at a minimum each trainer could be shared between two students. However, the trainers could be used to fill the last of a student's secondary training. They would give the student a broader knowledge of the material, a greater experience and understanding of the field, and they would stimulate the student's curiosity for further study in this field.

Another area an instructor may want to cover if time permits is electric/electronic equipment patching. This consists of connecting parts together, such as phonograph, power supply, and loud speakers, from different manufacturing firms so that they work as a functional unit. Generally when these parts are connected without proper matching, one, if not all, become damaged. The pilot instructor for industrial electricity mentioned the need for this section. Students will find this material useful in their home as well as their automobile. Unfortunately, the reference material for this subject is extremely hard to find and is very technical when it is found.

The beginning of Book III gives an occupational introduction to the commercial electrican.

The first section deals with inductance, capacitance, reactance, RC time constants and Series & Parallel RCL circuits. It come from Basic Electronics and is a continuation of Section D that began at the end of Book II.

Another occupational introduction follows about the locomotive electrician.

Although the guide mentions introducing the oscilloscope in Instruments I, it has been withheld to this point because its expense would very possibly limit an adequate number for a high school program. This instrument is not beyond the understanding of a secondary student nor is it too delicate. Even so, a secondary instructor should have at least one for his own classroom use. Anyway, the oscilloscope should be covered in Instruments II thoroughly. Plus a review of VOM, VTVM, clamp-on meters would be good. Also included should be meggers, continuity checkers, test lamps, voltage indicators, watt meters, watt-hour meters, light meters, sound level meters, temperature indicators, and recording meters. This material should cover the selection, proper use, and care of each instrument as well as a thorough coverage of calibration and replacing meters.

The following section on Troubleshooting needs to be written. It should teach the student how to select the proper instrument to locate typical faults in wires, cables, and connectors as well as fuses and breakers. The student should be able to troubleshoot faults in switches, relays, resistors, capacitors, inductors, transformers, motors, and generators. The last unit in this section could instruct the student in the proper use of block diagrams and schematics as a troubleshooting guide and have the student locate faults in a system to the functional unit or circuit.

Refrigeration is the next section. This material is an introduction to refrigeration systems and components.

The industrial electrician's occupation is introduced next.

Instrumentation III should cover signal generators (both AF and RF), signal tracers, capacitor checkers, transistor testers, logic probes and the use of test jigs and fixtures. The student shoud apply and trace a signal through an electronic system with the listed equipment. The condition of transistors, vacuum tubes and integrated circuits should be determined. Bad or leaky capacitors and inductors should be identified and parts value should be determined with maxium accuracy. An example of using a test jig should be presented.

Book IV begins with Electronic Devices and gives the student a good coverage of many of the electronic parts.

In the section on Instrumentation IV the student should learn to describe the features and characteristics of frequency counters, grid-dip meters, RF power meters, RF sweep generators, distortion analyzers and special test and calibration equipment. These meters and their application should be covered in detail.

Advanced troubleshooting should challenge the student to locate and identify common faults of electric and electronic components typically found in systems

and circuits. The ability to select the proper test instrument and locate the typical faults of diodes, vacuum tubes, semi-conductor devices, sensors and transducers, should be demonstrated as well as the ability to define the function of each component in a typical electronic circuit. And the ability to locate, remove and replace faulty components following logical troubleshooting procedures should be demonstrated. As a summary to this section, the article by Earnest Hopkins on What You Need to Know to Troubleshoot! should be reviewed with the student. He has given his permission to reproduce his article. Also, the student should be able to work from and wire block diagrams and schematics, plus know the proper procedure to shut down a given area.

At this point the industrial electrician is through. Assuming that time permits an instructor may want to conclude the industrial electricity training with any of one to seven electric motor control trainers produced by Electronic Training Materials, Inc. These seven trainers thoroughly cover the industrial control of AC-DC motors. Although these panels could be used to teach controls, they have been located here to better present troubleshooting and prepare the student for employment.

Even so, if enough interest is present the continuation to the electrical technician could be accomplished. An introduction to this occupation is presented.

A section on Power Component Identification should be covered. And the material of this section gives a good coverage of the area.

A section on Advanced Motors should also be written. The student should be able to: check, lubricate and/or replace bearings; replace brushes; replace or adjust certrifugal switches; rewind stators, rotor and field windings; test pole piece polarities; balance rotors and reassemble motors with proper end play; test windings, components and connections for shorts, grounds and opens; replace defective

parts, such as wires, capacitors, connectors and cables; repair and adjust small motors, and use motor test equipment and tools such as the Growler both external and internal, test light, coil winder, compass and under cutter.

And, the final section that needs to be written to complete the electrical technician's training is on logs and reports. The student should be shown how to keep accurate laboratory and shop activity records, communicate technical information and keep proper logs.

The intent in designing the curriculum for industrial electricity has been to adhere to the MAVCC format. In order to accomplish this task it was necessary to rearrange some of the material that the consortium had already published.

In this manner, the material is in the desired format while meeting the objective of an instructive guide for industrial electricity.

When the table of contents of the curriculum is noted for the source it came from, (see page 22) it is apparent that the material is derived from six Mid-America and two Oklahoma publications. Plus, seven of the units were written by Leigh Hargis and one unit is reprinted with permission by Ernest Hopkins from Electricity Occupations Curriculum Guide, July, 1975.

The texts used to compile this curriculum are arranged in alphabetical order and assigned a letter. This letter is used to notate that text in the table of contents.

The basis of Book I is the Mid-America publication, Residential Wiring. Inserted into this core are units from the other texts as noted.

The other three books are compiled from the units and section of the consortium guides in an attempt to adhere to the outline that was drawn from the Illinois determination of educational blocks.

The area director at the most recent south-wide research review meeting made contact with V-Tecs and was able to obtain a copy of their Industrial Electricity Guide. Also, he established contact with Robert K. Mabry, who is coordinator for Vocational Education Division of Program Development for the state of Georgia. Mr. Mabry said that Georgia is 20 months into development of an industrial electricity curriculum that is articulated (secondary to post-secondary) with audio-visuals, etc. and that we were welcome to see it when it is finished in about three months. Also, Mr. Mabry mentioned that he felt that the V-Tecs catalog is very elementary.

Since taking this guide and comparing it with what has been compiled here, Mr. Mabry's comments about the guide's elementary nature is probably right; yet, the final curriculum could not cover much more material; even though, it does not cover as much as what has been compiled in our curriculum.

The guide covers 186 tasks, and this compiled guide has 223 job sheets which makes written comparisons tedious. The guide did cover material that has been forgotten in this compilation and gave us a chance to remedy that oversight. All of the 186 tasks are not covered. However, the compilation of Mid-America material does cover much more material than the V-Tecs guide. Plus, this material, that has been drawn from many sources, can start a student from zero; the V-Tecs guide cannot! When this curriculum is complete it will be more than comparable to what Georgia is about to produce. When requesting information from the various states that a state department source had given, Georgia sent a Field Review Copy of Industrial Electricity for the post secondary. Should this be the same material that they will produce later this summer, then it is absolutely unacceptable for our use.

To get an idea of the ease of using the guide that is being put together, first, all the ground and field work has been done on this material. Second, all the

classroom testing has been completed on at least 90 percent of this material. Third, the format is exactly as is desired. To put it another way, the material is there for us. Why should we not use it?

The difficulties of compiling this material are minor! The major problem is getting people to adjust to this line of thought and do what work is needed. It can be done if we can get the people motivated!

A summary to what has been done in this research follows. The task at the beginning of this project was to write a report on industrial electricity, keeping in mind that the secondary and post-secondary schools may want to use the results. Fate was kind in providing a guide with more than adequate field research. The format for the requested material was the Oklahoma/Mid-America style. It seemed only logical to combine the two in such a manner that the necessary purposes were met. The curriculum for industrial electricity has been drawn from eight Oklahoma/Mid-America consortium guides. This research has almost been accomplished. What remains is whether the people above this station care to use the findings?

IMPLEMENTATION

Duplication of the compiled Mid-America curriculum material is the major obstacle to implementation of this program. There are 2,000 pages to the secondary material that are drawn from six of the eight Mid-America notebooks used to develop this material. The per student expense in ordering the six books and rearranging the material at each school does tend to be excessive, as is the cost of copying the material via of a zerox. Therefore, forecasting of a time table concerning budget requirements is beyond this researcher's scope.

However, if the 3,300 pages of the four books were published this summer, a program could begin in the fall. The vast majority of the material is available. The question is really "Does Arkansas want to lead the nation with a complete curriculum for industrial electricity?"

SKILL ENTRY LEVEL
FLOW CHART
START
Safety
Basic Electrical Parameters
Drawings & Specs-Electrical
Cleaners & Lubricants
Hand Tools I
Instruments & Measurements I
Component Identification
Electrical Component Identification
Codes
Soldering
Instruments & Measurements II
Wiring I
Tools II
Wiring II
Switches, Fuses, and Breakers
Finish Wiring
Electrical Troubleshooting I
1 Route: L.E. to 3, E.T. to 3
Rewire & Modify
2 Route: A.E. to 3; C.E. to 3; I.C. to 3
I.E. to 3
Customer Relations
Residential Electrician 3
Functions of Components
Basic Circuit Configuration
Drawings & Specs-Mechanical
AC Motors & Generators
Control Systems
4 Route: E.T. to 6
Handling & Rigging
5 Route: C.E. to 6; I.C.E. to 6; L.E. to 6
Welding
Agricultural Electrician 6
Transf. & Capacitors
DC Motors & Generators
Electronic Circuit Fundamentals
Drawings & Specs-Electronic
Industrial Construction Electrician 7 Route: I.E. to 8; L.E. to 8; E.T. to 8
Electrical Parameters II
Commercial Electrician 8
Electronic Troubleshooting I
Electrical Troubleshooting II
Tools III
9 Route: I.E. to 10; E.T. to 10
Refrigeration
Locomotive Electrician
Locomotive Electrician 10
Electronic Troubleshooting II
Instruments & Measurements III
Industrial Electrician 11
Power Component Identification
Motor Repair
Instruments & Measurements IV
Logs & Reports
Electrical Technician 12

ILLINOIS GUIDE
ELECTRICIAN'S FLOW CHART

START

Safety
Basic Electrical Parameters
Drawings & Specs-Electrical
Cleaners & Lubricants
Hand Tools I
Instruments & Measurements I
Component Identification
Electricial Component Identification
Codes
Soldering
Instruments & Measurements II
Wiring I
Tools II
Wiring II
Switches, Fuses, and Breakers
Finish Wiring
Electrical Troubleshooting I

1 Route: L.E. to 3; E.T. to 3

Rewire & Modify

2 Route: A.E. to 3; C.E. to 3; I.C. to 3
I.E. to 3

Customer Relations

Residential Electrician — 3

Functions of Components
Basic Circuit Configuration
Drawings & Specs-Mechanical
AC Motors & Generators
Control Systems

4 Route: E.T. to 6

Handling & Rigging

5 Route: C.E. to 6; I.C.E. to 6; L.E. to 6

Welding

Agricultural Electrician — 6

Transf. & Capacitors
DC Motors & Generators
Electronic Circuit Fundamentals
Drawings & Specs-Electronic

Industrial Construction Electrician — 7 Route: I.E. to 8; L.E. to 8; E.T. to 8

Electrical Parameters II

Commercial Electrician — 8

Electronic Troubleshooting I
Electrical Troubleshooting II
Tools III

9 Route: I.E. to 10; E.T. to 10

Refrigeration
Locomotive Electrician

Locomotive Electrician — 10

Electronic Troubleshooting II
Instruments & Measurements III

Industrial Electrician — 11

Power Component Identification
Motor Repair
Instruments & Measurements IV
Logs & Reports

Electrical Technician — 12

COMPILED CURRICULUM
ELECTRICIAN'S FLOW CHART

START

Orientation
- Occupational Introduction - Residential Electrician
- General Safety
- Electrical Safety
- Treatment of Electric Shock Victims

Tools
- Pouch Tools
- Hand Tools
- Specialty Tools
- Soldering

Basic Theory
- Ohm's Law
- Basic Theory
- Conductors, Cables, and Cords
- Electrical Test Instruments

Using Trade Information
- The National Electrical Code
- Wiring Diagrams
- Blueprints and Specifications

Lubricants and Cleaners
- Lubricants
- Cleaners

Basic Equipment and Procedures
- Equipment
- Wiring Methods
- Load Centers

Wiring Residential Circuits
- Overcurrent Protection
- New Construction: Box Location and Planning and Installation
- Switching Situations
- Receptacle Outlets
- Combination Circuits
- Low Voltage Wiring
- Residential Service Installations
- Trim Out

Existing Dwellings
- Calbe Installations
- Box Installations
- Load Center Changes

Related Information
- Troubleshooting
- Customer Service
- Take Off and Estimate
- Applying for a Job
- Batteries

Residential Electrician 1

Introduction
- Occupational Introduction - Agricultural Electrician

Functions of Components
- Basic Electric Thermostats
- Relays
- Protection Devices
- Capacitors

Power and Its Transfer
- Electric Power
- Power
- Conductors and Insulators
- Power Transmission

Motors I
Introduction to Electric Motors
Split-Phase Motors
Shaded-Pole Motors
Capacitor Motors
Three Phase Motors
Controls
Rope and Rigging
Rope and Rigging
Welding
Soldering and Welding Equipment
Soft Soldering
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B. Air Conditioning and Refrigeration - Book Two - Mid America

C. Automotive Mechanics II — Oklahoma

D. Basic Electronics I — Mid-America

E. Basic Electronics II — Mid-America

F. Mechanical Drafting — Mid-America

G. Power Line Technician — Oklahoma

H. Residential Electrician — Mid-America

I. Electricity Occupations Curriculum Guide, Illinois Office of Education Division of Vocational and Technical Education, July, 1975.

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Reprinted with permission from Electricity Occupations Curriculum Guide, July, 1975.

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RESIDENTIAL WIRING

Student Material

Mid-America Vocational Curriculum Consortium Inc.

AIR CONDITIONING AND REFRIGERATION
BOOK ONE

by
Gary W. Wantiez

Developed by the
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Volume II

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by

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Power Line Technician's Training

Instructional Units

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BIBLIOGRAPHY

Adams, James E. Electrical Principles and Practices. McGraw-Hill, Inc., Second Edition, 1963.

Alerich, Walter N. Electrical Construction Wiring. American Technical Publishers, Inc.,1971.

Arkansas Department of Labor. Electrical Hazards Control Manual. 1977.

Birt, H.B. The Battery Side of Voltage Regulation. Delco-Remy Division. 1952.

Culpepper, Fred W. Jr. Rex Miller. Energy: Electricity/Electronics. South-Western Publishing Company, 1982.

D-C Equipment & Controls. Technical Publishing Company, 1974.

Dees, Sherwood, Director, Electricity Occupations Curriculum Guide, Illinois Office of Education, Division of Vocational and Technical Education, July, 1975.

Driscoll, Edward F. Industrial Electronics. Devices, Circuits, and Applications. American Technical Publishers, Inc., 1976.

Edwards, Kenneth R. Kenneth L. Gebert. Transformers. Principles and Applications. American Technical Publishers, Inc., Second Edition, 1981.

Ford, Walter B. William B. Steinberg. Electricity and Electronics - Basic. American Technical Publishers, Inc., 1972.

Gebert, Kenneth L. National Electrical Code Blueprint Reading. American Technical Publishers, Inc., Eigth Edition, 1980.

Hubert, Charles I. Preventive Maintenance of Electrical Equipment. McGraw-Hill Book Company, Second Edition, 1969.

Kubala, Thomas S. Electricity I, Devices, Circuits, Materials. Delmar Publishers, Inc. Third Edition, 1981.

Lubrication-Proper Selection and Use of Lubricants Within the Plant. Technical Publishing Company, 1974.

McIntyre, R.L. Electric Motor Control Fundamentals. McGraw-Hill, Inc. 1974.

Miller, Rex. Industrial Electricity. Charles A. Bennet Company, Inc. 1978.

Mullin, Ray, C. Electrical Wiring Residential. Delmar Publishers, 1975.

National Electrical Code 1981. National Fire Protection Association, 1980.

Principles of Lubrication. Exxon Corporation, 1973.

Regulation and the Charging Circuit. Delco-Remy.

Rockis, Gary. Residential Wiring. American Technical Publishers, Inc., 1978.

Seippel, Robert C. Fundamentals of Electricity, Basics of Electricity, Electronics, Controls, and Computers. American Technical Publishers, Inc. 1974.

Shrader, Robert L. Electrical Fundamentals for Technicians. McGraw-Hill, Inc. Second Edition, 1977.

Smith, Robert L. Electrical Wiring Industrial. Delmar Publishers, 1977.

Wildi, Theodore, Michael J. De Vito. Investigations in Electric Power Technology. Buck Engineering Company, Inc. 1971.

ALTERNATIVE

As the months have passed since writing the previous material, it seems that the students could be short-changed if they were subjected to a piece-meal curriculum. At the time it seemed that the need required the most expedient method. However, now that AP&L has postponed the Sparta mine (see enclosure) to the 1990's, it seems much wiser to develop the entire curriculum with the industrial electrician the sole recipient.

Because of the lack of time, a complete reparation is not possible and should not be necessary. However, some areas will have to consider the possible advances of technology.

The previous material can be useful. The flow charts should be of benefit to anyone who works with an industrial electricity curriculum. And, the sources could greatly benefit any committee developing a curriculum. Another item that could help is the publication by the Illinois Office of Education Electricity Occupations Curriculum Guide 1975.

There are several areas that need to be observed for technological improvements and advancements. The major limitation to solar electricity and the electric car is the battery. The aforementioned publication, Electricity Occupations Curriculum Guide 1975, neither mentioned batteries nor the following. The increasing use of robotics and the computer is creating new challenges to industrial electricians, which will require a thorough understanding of pneumatics, hydraulics, and in time computers devices.

The challenge to the Mid-America Vocational Curriculum Consortium is to serve the needs of the community that it covers. And, a need is to develop industrial electricians who are able to maintain the frontiers of our industries. How will the consortium respond?

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Preface

The determination of occupations within the local area industries for metallurgy is difficult. The reason is the definition of metallurgy, which is the art and science of separating metals from their ores and preparing them for use. This field is so large that it is separated into two large branches, extractive metallurgy and physical metallu gy. Extractive metallurgy deals with taking metals from their ores and refining them. And, physical metallurgy is the branch covering adapting metals to human use.

Due to the extremely limited need Arkansas would have for extractive metallurgy, this report has dealt entirely with the physical branch of metallurgy and has attempted to outline curriculum material for the benefit of the occupations that would most benefit Arkansas industry.

The meetings with industry has been helpful. And, the major comment is that the students need as much practical application as possible. And, they are right. However, the students must have the necessary knowledge to be able to succeed in a practical application.

From the Dictionary of Occupational Titles a listing of the various trades found within this area was made. The educational blocks have been drawn and arranged in a curriculum format. Please refer to page 73 to note the occupation/educational block cross reference chart. An instructor should be able to use this chart and the curriculum outline to teach any one of the occupations listed. And, up to a point, the material is designed to accept the machinist and the welder in the same classroom.

Occupations

Few people out of a secondary program would be as qualified for a position as a person from a post-secondary program. And, this may be the only difference in this field that determines the industries for which a student can enter. Every occupation listed in the field of metallurgy has only one major difference and that is the degree of knowledge or experience. The Dictionary of Occupational Titles gave insight to the occupations within this area and are reprinted on pages 44 to 72.

Entry Level Skills

The skills that a person should have for the twenty occupations varies more as to expertise than the level of education. Of course, expertise can be taught for it is only a more complete understanding of the work. Therefore, a logical approach seems to be the degree of coverage between the secondary and post-secondary. A secondary could instruct students to a relative understanding of the subject and a post-secondary could take the student's skills to a level of mastery. To put this in another manner, the post-secondary should complement the secondary programs. Currently, this is not done in Arkansas, and is a major problem with the programs. Both secondary and post-secondary cover the same material. Each one does have its place. And, if they would work as a unit the outcome and products would be much better.

A skill/educational block chart was developed from the Dictionary of Occupational Titles, see page 73 . As mentioned, the skill levels vary with the degree of expertise. The secondary would not need to know much about Chapter III except maybe Unit 5 on Abrasives nor would the

secondary student need the latter units on Chapter VII or Chapter VIII. These chapters could be developed by the post-secondary, where a student should be able to improve skill and ability.

Program

An outline for a metallurgy program was developed from the skill/educational block chart. Using these two guides an instructor could develop a course for any one of the twenty occupations listed.

Even so, a cohesive program beginning with the secondary could use the outline and start with Chapter I, followed by Chapter II. At this point the secondary could go to the fifth unit of Chapter III on abrasives. Then, Chapter IV and V. Now, the determining factor would be the student interest. Some instructors may go to Chapter VII and others Chapter VIII. However, a broader background could be developed by covering the first unit of Chapter VII and the first two units of Chapter VIII. The three units of Chapter VI could be covered as an interlude between projects that an instructor could develop for the welding and machinery chapters.

A post-secondary program could use the same format except not skipping any units until Chapter VI, which could be skipped to allow the students to begin the projects that an instructor would develop for the last two chapters and could return to Chapter VI as the student interest developed. Students who come from secondary programs and can test out of material could advance to the projects until the course catches up to them.

The type of equipment that this course would require are already found in most school shops, except possible the Rockwell and Brinell Hardness

testing machines. The material for Chapter VI would require some special devices, but they are either easily obtained or already located in the shop.

Implementation

A program of this nature could begin most any time. However, it would seem best to begin the program at the same time at both the secondary and post-secondary. Justification is that the program would become more unified as a whole with the two programs running currently. And, after the initial two years, students coming from the secondary to the post-secondary would be able to finish the course sooner.

JOB TITLE ELECTROPLATER DOT # 500.380-010

ALTERNATE TITLES Immersion Metal Cleaner, Plating Stripper, Brass Plater, Bronze Plater, Chromium Plater, Plastics Plater, Silver Plater, Tin Plater

EMPLOYING INDUSTRIES Any metal coating industry

COMMENT: Job requires minimal knowledge of basic fundamentals but a great deal of hands-on practical work.

JOB DESCRIPTION:

Sets up and controls plating equipment to coat, strip, clean or repair (via build up on worn surfaces) according to specifications. Reads work order to determine size and composition of object to be plated, type concentration and temperature of plating solution, type and thickness and location of specified plating metal, and amount of electrical current and time required to complete plating process.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Reads work order to determine the job requirements.
3. Immerses object in cleaning and rinsing baths.
4. Suspends object from cathode rod (negative terminal) and immerses object into plating solution.
5. Suspends piece of plating metal from anode (positive terminal) and immerses metal into plating solution.
6. Moves controls on rectifier to adjust current flow through plating solution from anode to cathode to permit electrodeposition of metal on object.
7. Removes plated object from solution at periodic intervals and makes observations to insure conformance to specifications.
8. Adjusts voltage and amperage based on observations.

Electroplater (2)

9. At the end of process examines objects visually to determine thickness of metal deposit or measures thickness using instruments, such as micrometers or calipers.

10. Grinds , polishes or rinses object in water and dries object to maintain clean even surfaces.

JOB TITLE HEAT TREATER DOT # 504.382-014

ALTERNATE TITLES Hardness Inspector, Industion-Machine Setter

EMPLOYING INDUSTRIES Any metal manufacturing, fabricating or treating industry

JOB DESCRIPTION:

Controls heat-treating furnaces, baths, and quenching equipment to alter physical and chemical properties of metal objects using specifications and methods of controlled heating and cooling, such as hardening, tempering, annealing, case-hardening, and normalizing.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly load parts into furnace and remove parts after prescribed time.
3. Using standard heat-treating charts and knowledge of heat-treating methods, equipment and properties of metals, determine temperature and time of heating cycle and type and temperature of baths and quenching medium to attain specified hardness, toughness, and ductility of parts.
4. Properly adjusts furnace controls and observes pyrometer to bring furnace to prescribed temperature.

JOB TITLE POWDERED METAL SUPERVISOR DOT # 509.130-010

EMPLOYING INDUSTRIES All Powdered Metal Industries

COMMENT: Job requires not only the normal duties of a superviosr; but also, the special knowledge and activities of powdered metal production.

JOB DESCRIPTION:

Supervises and coordinates activities of workers engaged in mixing and pressing metal powders, and in sintering, coining, impregnating, and inspecting powdered metal products, applying knowledge of powdered metal properties, press and durance operation, and sintering and impregnating processes. Trains workers in setup of machines and equipment. May set up briquetting and coining presses and sintering furnaces.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Applies knowledge of powdered metal properties, press and durance operation and sintering and impregnating process to supervise and coordinate activities of workers.
3. Inspects powdered metal products.
4. Trains workers in setup of machines and equipment.

JOB TITLE MOLDER DOT # 518.361-010

ALTERNATE TITLES Injection molder, bench molder, floor molder

EMPLOYING INDUSTRIES All metal foundries and casters

JOB DESCRIPTION:

Forms sand molds for production of metal castings, using handtools, power tools, patterns or match plates, and flasks, and applying knowledge of variables, such as metal characteristics, molding sand, contours of patterns, and pouring procedures: Positions drag half of pattern and flask on follow board. Sprinkles or sprays parting agent on pattern and flask and positions reinforcing wire in flask. Sifts sand over pattern, using riddle and presses sand around contours of pattern. Shovels sand into flask and packs it in place, using hand ramming tools or pneumatic hammer. Turns drag over and positions cope half of pattern and flask on drag. Repeats molding operation to make cope. Lifts cope from drag and removes pattern. Cuts runner and sprue hole into mold and repairs damaged impressions, using molder's handtools, such as slick, trowel, spoon, and sprue cutter. Positions specified cores in drag and reassembles cope and drag. Signals Bridge or Gantry Crane Operator to move and position large flasks, patterns, and bottom boards, or moves them, using chain hoist. Pours molten metal into mold, using ladle. May form and assemble slab cores around pattern to reinforce mold, using handtools and glue. May harden molds by blowing carbon dioxide gas on them or by injecting gas into molds. May form small molds on bench or form large molds on floor.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Applying knowledge of variables (metal characteristics, molding sand, countours of patterns and pouring procedures), forms sand molds for production of metal castings.

3. Properly uses hand tools.
4. May harden molds by injection molding process.
5. Repairs damaged molds and impressions.

JOB TITLE HARDNESS INSPECTOR DOT # 504.387-010

EMPLOYING INDUSTRIES All foundaries and heat treatment plants

JOB DESCRIPTION:

Tests metal objects to determine their hardness, using hardness testing equipment: Positions workpiece on anvil of testing machine and turns controls to press steel ball or diamond point against surface of piece or to allow diamond-pointed hammer fall on surface to be tested. Measures diameter of indentation caused by steel balls, using microscope, or reads scale on test equipment that indicates depth of penetration of ball or diamond point, or calibrated height of hammer rebound. Reads hardness number from calibrated scale on equipment or converts scale reading to hardness number, using formula or conversion chart. Important variables may be indicated by trade names of equipment used. May cut cross section of sample part and examine part under microscope to determine hardness depth.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly use hardness testing machine.
3. Properly uses measuring and calibration devices.
4. Must be able to prepare a sample and examine part with microscope to determine hardness depth.

JOB TITLE MACHINIST DOT # 600.280-022

ALTERNATE TITLES First class machinist, general machinist, precision machinist, lay out worker

EMPLOYING INDUSTRIES Machine Shop

JOB DESCRIPTION:

Sets up and operates machine tools, and fits and assembles parts to make or repair metal parts, mechanisms, tools, or machines, applying knowledge of mechanics, shop mathematics, metal properties, and layout and machining procedures: Studies specifications, such as blueprint, sketch, damaged part, or description of part to be replaced, to determine dimensions and tolerances of piece to be machined, sequence of operations, and tools, materials, and machines required. Measures, marks, and scribes diminensions and reference points to lay out stock for machining. Sets up and operates metal-removing machines, such as lathe, milling machine shaper, or grinder, tc machine parts to specifications. Verifies conformance of workpiece to specifications, using measuring instruments. Positions and secures workpiece in holding device, such as chuck or collet, or an surface plate or worktable with such devices as vises, V-blocks, and angle places, and uses hand-tools such as files, scrapers, and wrenches, to fit and assemble parts to assemblies or mechanisms. Verifies dimensions and alinement with measuring instruments, such as micrometers, height gages, and gage blocks. May operate mechanism or machine, observe operation, or test with inspection equipment, to diagnose malfunction of machine or to test repaired machine. May perform flame cutting and arc or gas welding operations, when required. May develop specifications from general description and draw or sketch product to be made.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly uses hand tools, such as files, scrapers, and wrenches.

Machinist (2)

3. Assembles and repairs metal parts, mechanisms, tools, or machines.

4. Applies knowledge of mechanics, shop mathematics, metal properties and layout and machining procedures.

5. Must be able to obtain specifications from blueprint, sketch, damaged part or general description.

6. Sets up and operates metal-removing machines, such as lathe, milling machine, shaper, or grinder to machine parts to specifications.

7. May perform flame cutting and arc or gas welding operations.

JOB TITLE TOOL AND DIE MAKER DOT # 601.280-046

ALTERNATE TITLES Lay out worker, tool-machine set-up operator

EMPLOYING INDUSTRIES Machine Shop

JOB DESCRIPTION:

Analyzes specifications, lays out metal stock, sets up and operates machine tools, and fits and assembles parts to make and repair metal working dies, cutting tools, jigs and fixtures, gages, and machinists' handtools, applying knowledge of tool and die designes and construction, shop mathematics, metal properties, and layout, machining, and assembly procedures: Studies specifications, such as blueprints, sketches, models, or descriptions, and visualizes product. Computes dimensions and plans layout and assembly operations. Measures, marks, and scribes metal stock for machining. Sets up and operates machine tools, such as lathe, milling machine, shaper, and grinder, to machine parts, and verifies conformance of machined parts to specifications. Lifts machined parts manually or using hoist, and positions and holds them on surface place or worktable, using devices, such as vises, V-blocks, and angle plates. Smooths flat and contoured surfaces, using scrapers, abrasive stones, and power grinders, and fits and assembles parts into assemblies or mechanisms. Verifies dimensions, alinements,and clearances, using measuring instruments, such as dial indicators, gage blocks, thickness gages, and micrometers. Dowels and bolts parts together, using handtools, such as hammers and wrenches. May connect wiring and hydraulic lines to install electric and hydraulic components. May heattreat tools and parts. May examine standard or previously used tools or dies and decide on modifications to be made. May develop specifications from general descriptions and make drawing or sketch of product. May specialize in repair work and be designated tool and die repairer.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.

2. Properly uses hand tools.

3. Applies knowledge of tool and die designs and construction, shop mathematics, metal properties, and layout, machining, and assembly procedures.

4. From specifications, such as blueprints, sketches, models, or general description computes dimensions, plans layout, and assembly operations.

5. Set up and operates machine tools, such as lathe, milling machine, shaper, or grinder to machine parts and verifies conformance to specifications.

JOB TITLE TOOL ROOM LATHE OPERATOR DOT # 604.280-010

ALTERNATE TITLES Precision lathe operator, tool room lathe operator, tracer-lathe set-up operator

EMPLOYING INDUSTRIES Machine Shop

JOB DESCRIPTION:

Sets up and operates engine lathe to perform machining, such as turning, facing, boring, and threading on rotating metal castings, forgings, and bar stock, to machine tool, die or machine parts, analyzing specifications and deciding on tooling according to knowledge of metal properties and lathe operation: Studies blueprint or layout on workpiece to visualize machining to be done, and plans sequence of operations. Selects method of holding workpiece according to its size and shape and installs holding fixtures, and such as chuck jaws, collets, arbors, and mandrels, to headstock or tailstock, using clamps or wrenches. Lifts workpiece manually or with hoist, and positions and secures it in holding fixture or between centers, using clamps and wrenches, and verifying position with measuring instruments, such as calipers, height gages, and dial indicators. Selects feed rate, cutting speed, depth of cut, and cutting tool for each operation, according to knowledge of metal properties and shop mathematics. Positions and secures cutting tool in tool holder on cross-slide or tailstock. Moves controls to set cutting speed and feed rate and to position tool in relation to workpiece. Starts machine and turns handwheels to feed tool to and along workpiece, or engages automatic feed. Turns valve handle and directs flow of coolant against tool and workpiece. Verifies conformance of machined workpiece to specifications, using measuring insturments, such as micrometer, calipers, and depth gages. May operate large engine lathe to machine large objects, such as ship propeller shafts, and be designated lathe set-up operator, large. May offset position of tailstock to machine tapered surfaces. May mount gears, move levers, and engage threading dial to machine threads, using knowledge of thread cutting. May machine teeth on cutting tools, or duplicate contours from templates or models, using

TOOL ROOM LATHE OPERATOR 2.

relieving or tracing attachments. May operate bench grinder to sharpen tools. May work on nonmetallic materials,such as plastics. May be required to have specialized experience with particular materials, product, precision level, machining process, or size, type or trade name of machine.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Sets up and operates engine lathe to perform machining, such as turning, facing, boring, and threading on rotating metal castings, forgings, and bar stock, to machine tool, die or machine parts.
3. Applies knowledge of metal properties and lathe operation to analyze specifications and decide on tooling.
4. Selects method of holding workpiece according to its size and shape and installs holding fixture.
5. Selects feed rate, cutting speed, depth of cut and cutting tool for each operation.
6. Uses measuring instruments to verify conformance of machined workpiece.
7. May work on nonmetallic materials, such as plastics.

JOB TITLE BORING MACHINE SET-UP OPERATOR DOT # 606.280-010

ALTERNATE TITLES Jig-Borer

EMPLOYING INDUSTRIES Machine Shop

JOB DESCRIPTION:

Sets up and operates jig borer to perform machining operations, such as boring, drilling, reaming, and counterboring holes in metal workpieces, such as jig, fixtures, gages, and dies, according to specifications, applying knowledge to metal properties, tooling, and precision machining. Studies machining instructions, such as job order, blueprint, process sheet, or layout on workpiece to determine dimensional and finish specifications, sequence of operation, setup, and tooling requirements. Lifts workpiece either manually or with hoist onto machine table. Positions and secures workpiece on table with bolts, clamps, shims, or other holding devices, using machinists handtools. Verifies parallelism of reference lines on workpiece to axis of table motion, using dial indicator mounted in spindle. Establishes zero reference point on workpiece, such as at intersection of two edges or over hole location. Turns handwheel to adjust machine table to align spindle over point, using dial indicator. Sets table-position dial at zero, measures all machining locations from this zero point. Selects and sets cutting speeds, feed rates, depth of cut, and cutting tool according to machining instructions or knowledge of metal properties. Installs tool in spindle. Turns handwheels to lower tool to workpiece and engages automatic feed. Turns valve and directs flow of coolant or cutting oil over cutting area. Verifies location and dimensions of holes, using measuring instruments, such as dial indicator, gage blocks, telescoping gage, and internal micrometer. Works to tolerances as close as plus or minus 0.0001 inch. May work only from blueprint. May lay out reference lines and machining locations on workpiece, according to blueprint, using layout tools, such as rule, divider, and scriber, applying knowledge of shop mathematics and layout techniques. May fasten workpiece in holding fixture mounted on machine

table or clamp jig or template in position on workpiece. May operate machine manually throughout first piece operation to verify accuracy of setup. May sharpen tools on bench grinder.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Sets up and operates jig borer to perform machining operations, such as boring, drilling, reaming, and counterboring holes in metal workpieces, such as jig, fixtures, gages, and dies.
3. Applies knowledge of metal properties, tooling, and precision machining to meet specifications.
4. From machining instructions, such as job orders, blueprint, process sheet, or layout on workpiece determines dimensional and finish specifications, sequence of operation, setup, and tooling requirements.
5. Verifies parallelism of reference lines on workpiece to axis of table motion.
6. Establishes zero reference point on workpiece, such as at intersection of two edges or over hole location.
7. Selects and sets cutting speeds, feed rates, depth at cut, and cutting tool according to machining instructions.

JOB TITLE BLACKSMITH DOT #610.381-010

ALTERNATE TITLES Anvil Smith

EMPLOYING INDUSTRIES Any forging mill, self

JOB DESCRIPTION:

Forges and repairs variety of metal articles, such as tongs, edged tools, hooks, chains, machine and structural components, and agricultural implements as specified by work orders, diagrams, or sample parts: Heats metal stock in blacksmith's forge or furnace. Hammers stock into specified size and shape on blacksmith's anvil or positions stock on anvil of powerhammer and depresses pedal to hammer stock with varying force and rapidity. Forge-welds metal parts by heating and hammering them together. Devises jigs and fixtures, forges special handtools, such as hammers or chisels, and sets up form blocks. Tempers or anneals forged articles. May record type of repair or fabrication of tools or machine components performed during work shift to maintain daily activity report and records. May cut, assemble, and weld metal parts, using arc or acetylne welding equipment. May repair farm machinery and be designated as blacksmith, farm. May be designated according to articles forged as tool-dresser, special trackwork blacksmith.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly uses hand tools, such as hammer, cleaver, and anvil.
3. Assembles and repairs metal parts, mechanisms, and tools.
4. Applies knowledge of metal properties.
5. Must be able to obtain specifications from blueprint, sketch, damaged part, general description or experience.
6. Tempers or anneals forged articles.

JOB TITLE UPSETTER DOT # 611.462-010

EMPLOYING INDUSTRIES Machine shop, any press forging industry

JOB DESCRIPTION.

Sets up and operates closed-die forging machine equipped with horizontal ram and gripping die to expand end of hot metal bar stock: Alines and bolts specified dies and cams in machine, using rule, square, and wrenches. Pulls stock from furnace when color indicates forging temperature and inserts stock in gripping die against stop gage, using tongs or hoist. Presses pedal to close gripping die on stock and to advance ram, squeezing end of metal into gripping die cavity. Moves workpiece through series of dies to shape stock progressively to specifications. Verifies dimensions or forged piece, using set gages. May upset cold metal.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Sets up and operates closed-die forging machine equipped with horizontal ram and gripping die to expand end of hot metal bar stock.
3. Alines and bolts specified dies and cams in machine.
4. Properly uses hand tools, such as rule, square, and wrenches.
5. Pulls stock from furnace when color indicates forging temperature and inserts stock into gripping die.
6. Moves stock through series of dies to shape stock progressively to specifications.
7. Verifies dimensions of forged piece.

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JOB TITLE SINTERING PRESS OPERATOR DOT # 617.685-038

ALTERNATE TITLES Briquette press operator, coining press operator, compact press operator

EMPLOYING INDUSTRIES: Any powdered metal manufacturer

JOB DESCRIPTION:

Tends mechanical or hydraulic presses which compress metal powders into parts, such as bearings, gears, filters, and rings, and coin them to specified size: Pours metal powder into hopper. Starts press, observes operation, and notifies press setter of malfunctions. Examines finished part for nicks, burs, and cracks. Weighs parts on scale and measures dimensions, using micrometers or fixed gages to insure conformance to specifications. May adjust shuttle mechanism to regulate amount of powder in part. Places finished parts on tray or in stock pan. May write identifying information, such as mix number, number of parts, and date on tag, and attach it to tray or pan. Feeds parts into coining press to correct distortions created in sinking process. Removes parts from press and inspects them for burs or other inperfections. Places parts on tray or in stock pan. May tend forming presses that fabricate clockwork parts from powdered metal.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Operates presses which compress metal powders into parts.
3. Pours metal powder into hopper, starts press, and observes operation.
4. Examines finished part for nicks, burs, and cracks.

JOB TITLE JEWELER DOT # 700.281-010

ALTERNATE TITLES Bench worker, jewelry jobber, jewelry repairer, goldsmith, platinumsmith, sliversmith

EMPLOYING INDUSTRIES Jewelry

JOB DESCRIPTION:

Fabricates and repairs jewelry articles, such as rings, brooches, pendants, bracelets, and lockets: Forms model of article from wax or metal using carving tools. Places wax model in casting ring, and pours plaster into ring to form mold. Inserts plaster mold in furnace to melt wax. Casts metal model from plaster mold. Forms mold of sand or rubber from metal model for casting jewelry. Pours molten metal into mold, or operates centrifugal casting machine to cast article. Cuts, saws, files, and polishes article, using handtools and polishing wheel. Solders pieces of jewelry together, using soldering torch or iron. Enlarges or reduces size of rings by sawing through band, adding or removing metal, and soldering ends together. Repairs broken clasps, pins, rings, and other jewelry by soldering or replacing broken parts. Reshapes and restyles old jewelry, following designs or instructions, using handtools and machines, such as jeweler's lathe and drill. Smooths soldered joints and rough spots, using hand file and emery paper.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Fabricates and repairs jewelry articles.
3. Casts metal from plastic mold.
4. Properly uses hand tools, such as saws, files, and soldering torch.
5. Cuts, saws, files, and polishes jewelry.

JOB TITLE RIVETER DOT # 800.684-010

EMPLOYING INDUSTRIES Aircraft-Aerospace manufacturers, car builders

JOB DESCRIPTION:

Rivets structural members, assemblies, and parts of aircraft, missiles, space vehicles, and railroad cars, using portable riveting, dimpling, and drilling machines and handtools: Reads work orders, blueprints, and operation sheets to determine sequence of operations and type size and hole pattern of rivets. Removes temporary bolts or fasteners and inserts rivets in predrilled holes. Places drive head to rivet gun against rivet shank and pulls trigger to actuate hammer that spreads rivet, or spreads rivet, using rivet set and hammer. Rivets together adjoining edges of parts and assemblies, using portable rivet squeezer. Places two dies of rivet squeezer over head and shank of rivet and presses trigger to activate dies that flatten shank of rivet. Drills and reams rivet holds and drills out defective rivets. Forms dimples around rivet holes, using portable dimpling gun or stationary dimpling machine. May aline and assemble parts to be riveted, using jigs, holding fixtures, pins, clamps, and fasteners. May buck rivets.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Rivets structural members, assemblies, and parts.
3. Reads work orders, blueprints, and operation sheets to determine sequence of operations and type size and hole pattern of rivets.
4. Removes temporary bolts or fasteners and inserts rivets in predrilled holes.
5. Drills and reams rivet holes and drills out defective rivets.
6. May aline and assemble parts to be riveted.

JOB TITLE FITTER DOT # 801.261-014

ALTERNATE TITLES Jig fitter

EMPOLYING INDUSTRIES Any industry

JOB DESCRIPTION:

Lays out, positions, alines, and fits together fabricated parts of structural metal products in shop, according to blueprint and layout specifications, preparatory to welding or riveting: Plans sequence of operation, applying knowledge of geometry, effects of heat, and allowances for weld shrinkage, machining, and thickness of metal. Sets up face block, jigs and fixtures. Locates and marks centerlines and reference points onto floor or face block and transposes them to workpiece, using tape, chains, plumb bob, and squares. Moves parts into position, manually or by hoist or crane. Alines parts, using jack, turnbuckles, wedges, drift pins, pry bars, and hammer. Removes high spots and cuts bevels, using hand files, portable grinders, and cutting torch. Gives directions to welder, arc to build up low spots or short pieces with weld. Straightens warped or bent parts, using sledge, hand torch, straightening press, or bulldozer. Positions or tightens braces, jacks, clamps, ropes, or bolt straps, or bolts parts in positions for welding or riveting. May use transit to locate reference points and erect ladders and scaffolding to fit together large assemblies. May tack weld.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Lays out, positions, alines, and fits together fabricated parts of structural metal products.
3. Applying knowledge of geometry, effects of heat, and allowances for weld shrinkage, machining, and thickness of metal, plans sequence of operations.

JOB TITLE BOILERMAKER DOT # 805.261-014

ALTERNATE TITLES Assembly and erection boilermaker

EMPLOYING INDUSTRIES Any industry

JOB DESCRIPTION:

Assembles, analyzes defects in, and repairs boilers, pressure vessels, tanks, and vats in the field, following blueprints and using handtools and portable power tools and equipment: Locates and marks reference points for columns or plates on foundation, using master straightedge, squares, transit, and measuring tape, and applying knowledge of geometry. Attaches rigging or signals crane operator to lift parts to specified position. Alines structures or plate sections to assemble boiler frame, tanks, or vats, using plumb bobs, levels, wedges, dogs, or turnbuckles. Hammers, flame-cuts, files, or grinds irregular edges of sections or structural parts to facilitate fitting edges together. Bolts or arc-welds ports and bolts or welds support to frame. Alines water tubes and connects and expands ends to drums and headers, using tube expander. Bells, beads with power hammer, or welds tube ends to insure leakproof joints. Bolts or welds casing sections, uptakes, stacks, baffles, and such fabricated parts as chutes, air heaters, fan stands, feeding tube, catwalks, ladders, coal hoppers, and safety hatch to frame, using wrench. Installs manholes, handholes, valves, gages and feedwater connection in drums to complete assembly of water tube boilers. Assists in testing assembled vessels by pumping water or gas under specified pressure into vessel and observing instruments for evidence of leakage. Repairs boilers or tanks in field by unbolting or flame cutting defective sections or tubes, straightening plates, using torch or jacks, installing new tubes, fitting and welding new sections and replacing worn lugs on bolts. May rivet and calk sections of vessels, using pneumatic riveting and calking hammers. May line firebox with refractory brick and asbestos rope and blocks. May fabricate such parts as stacks, uptakes, and chutes, to adapt boiler to premises in which it is installed.

BOILERMAKER

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.

2. Analyzes defects in, assembles, and repairs boilers, pressure vessels, tanks, and vats.

3. Locates and marks reference points for columns or plates on foundation.
4. Alines structures or plate sections.
5. Hammers, flame cuts, files, or grinds irregular edges of sections.
6. Bolts or arc welds structures and sections together.
7. Assists in testing assembled vessels for evidence of leakage.

JOB TITLE ARC WELDER DOT # 810.384-014

ALTERNATE TITLES Carbon arc welder, tungsten arc welder, plasma arc welder flux-cored arc welder

EMPLOYING INDUSTRIES Any industry

JOB DESCRIPTION:

Welds together metal components of such products as pipelines, automobiles, boilers, ships, aircraft, and mobile homes, as specified by layout, blueprints, diagram, work order, welding procedures, or oral instructions, using electric arc-welding equipment: Obtains specified electrode and inserts into portable holder or threads consumable electrode wire through portable welding gun. Connects cables from welding unit to obtain amperage, voltage, slope, and pulse, as specified by welding engineer or welding technician. Starts power supply to produce electric current. Strukes (forms) arc which generates heat to melt and deposit metal from electrode to workpiece and join edges of workpiece. Manually guides electrode or gun along weld line, maintaining length of arc and speed of movement to form specified depth of fusion and bead, as speed of movement to form specified depth of fusion and bead as judged from color of metal, sound of weld, and size of molten puddle. Welds in flat, horizontal, vertical, or overhead positions. Examines weld for bead size and other specifications. May manually apply filler rod to supply wled metal. May clean or degrease weld joint or workpiece using wire brush, portable grinder, or chemical bath. May repair broken or cracked parts and fill holes. May prepare broken parts for welding by grooving or scarfing surfaces. May ship off excess weld, slag, spatter, using hand scraper or power chipper. May preheat workpiece, using hand torch or heating furnace. May position and clamp workpiece together or assemble them in jig or fixture. May tack assemblies together. May cut metal plates or structural shapes. May be designated according to type of equipment used as welder, carbon arc, welder, flux-cored arc; welder, gas-metal arc; welder, gas-tungsten arc; welder, hand, submerged arc:

welder, plasma arc; welder, shielded-metal arc. May be designated according to product welded as welder, boilermaker. Important variations include types of metals welded, subprocesses used, trade name of equipment used, worksite, method of application, high-production or custom, level of ambidexterity required, type of joints welded. May be required to pass employer performance tests or standard tests to meet certification standards of governmental agencies or professional and technical associations.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Welds together metal components as specified by layout, blueprints, diagrams, work order, welding procedures or oral instructions using electric arc-welding equipment.
3. Connects cables from welding unit to obtain amperage, voltage, slope, and pulse.
4. Starts power supply to produce electric current.
5. Strikes arc which generates heat to melt and deposit metal from electrode to workpiece to join edges of workpiece.
6. Manually guides electrode or gun along weld line, maintaining length of arc and speed to movement to form specified depth of fusion and bead.
7. Welds in flat, horizontal, vertical, or overhead positions.

JOB TITLE GAS WELDER DOT # 811.684-014

ALTERNATE TITLES Acetylene welder, oxyacetylene welder, oxyhydrogen welder

EMPLOYING INDUSTRIES Any industry

JOB DESCRIPTION:

Welds metal parts, using gas welding equipment as specified by layout, welding diagram, or work order: Positions parts in jigs or fixtures on bench or floor, or clamps parts together along layout marks. Selects torch, torch tip, filler rod and flux, according to welding chart specifications or type of thickness of metal. Connects regulator valves and hoses to oxygen and fuel gas cylinders, and welding torch. Turns regulator valves to activate flow of gases, lights torch and adjusts gas mixture and pressure, to obtain desired flame, based on knowledge of gas-welding techniques. Holds torch at proper angle to metal and guides along weld joint, applying filler rod to molten area to form weld. Examines weld for bead size and other specifications. Repairs broken or cracked metal objects, fills holes, and builds up metal parts. May apply flux or workpiece instead of filler rod. May preheat workpiece in furnace or with torch. May lay-out, position and tack weld workpieces. May weld along vertical or overhead weld lines. May scarf or groove weld prior to applying filler metal, using gas welding equipment. May ship or grind off excess weld, slag, or spatter. May clean or decrease parts, using wire brush, portable grinder, or chemical. May cut metal plates or structural shapes using gas torch. May be designated according to type of gases used such as welder, acetylene; welder oxyacetylene; welder, oxyhydrogen. Important variations include type of metals welded, products, subprocesses, trade name of equipment, owrksite, high-production or custom, level of ambidexterity required or type of joints welded (seam, spot, butt). May be required to pass employer performance tests or standard tests to meet certification standards of governmental agencies or professional and technical associations.

GAS WELDER

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Welds metal parts, using gas welding equipment as specified by layout, welding diagram, or work order.
3. Selects torch, torch tip, filler rod and flux, according to welding chart specifications or type and thickness of metal.
4. Connects regulator valves and hoses to oxygen and gas cylinders and welding torches.
5. Turns regulator valves to activate flow of gases, lights torch and adjust gas mixture and pressure, to obtain desired flame.
6. Holds torch at proper angle to metal and guides along weld joint, applying filler rod to molten area to form weld.

JOB TITLE WELD INSPECTOR DOT # 819.281-018

ALTERNATE TITLES Welding tester

EMPLOYING INDUSTRIES Government, any large industry

JOB DESCRIPTION:

Inspects and tests welded joints of work in progress and of completed units for visible defects, correct dimensions, joint strength, bead formation, weld penetration, and conformance with layout, blueprint, and work order specifications, applying knowledge of welding principles and metallurgical properties: Examines joint to detect flaws, such as cracks, cold weld, spatter, and under cuts, using flashlight and magnifying glass. Inspects joints for hidden cracks and pits, using magnaflux machine and ultrasonic testing equipment. Performs stress tests on joint, using stress testing equipment, or prepares sample for stress testing, and reviews results. Verifies alinement and dimensions of product and set up of machines and fixtures used for work in progress. Observes techniques and performance of welders in shop or at construction site. Marks defective pieces and recommends scrapping or methods for reworking. Records inspection data. Analyzes X-ray photographs of welded joints. May weld, test, and inspect metal samples to determine most effective welding process and technique, and be designated performance-test inspector.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Applying knowledge of welding principles and metallurgical properties, inspects and tests welded joints of work in progress and of completed units for visible defects, correct dimensions, joint strength, bead formation, weld penetration, and conformance with specifications.
3. Examines joint to detect flaws and hidden cracks and pits.
4. Performs stress tests.
5. Analyzes X-ray photographs.

JOB TITLE WELDER FITTER DOT #819.361-010

ALTERNATE TITLES Combination welder, tool and die welder, structural welder

EMPLOYING INDUSTRIES Any industry

JOB DESCRIPTION:

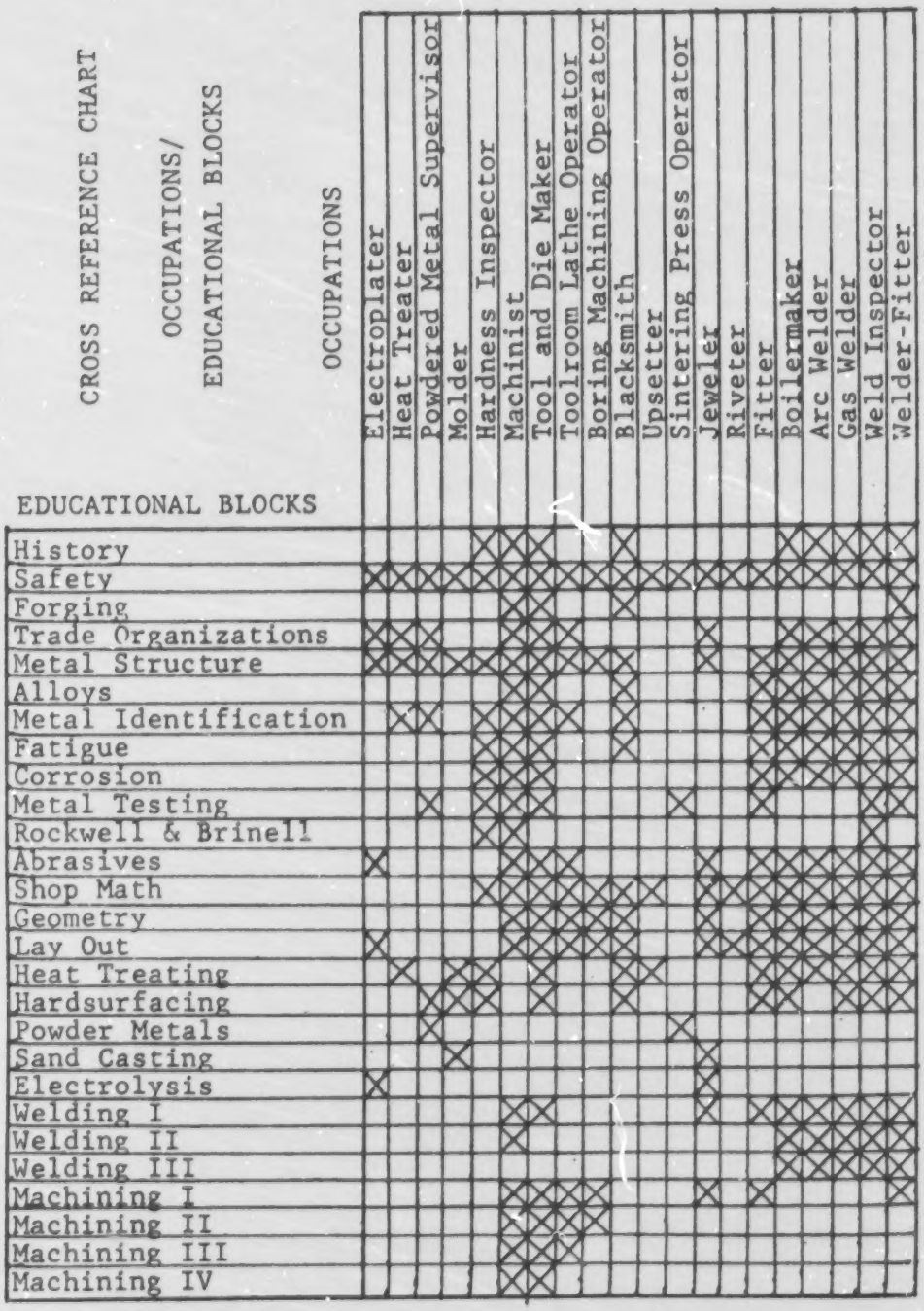
Lays out, fits, and welds fabricated, cast and forged components to assemble structural forms, such as machinery frames, tanks, pressure vessels, furnace shells, and building and bridge parts, according to blueprints and knowledge of welding and metallurgy: Selects equipment and plans layout, assembly, and welding applying knowledge of geometry, physical properties of metal machining weld skrinkage, and welding techniques. Lays out, positions alines,and fits components together. Bolts, clamps, and tack-welds parts to secure in position for welding. Sets up equipment and welds parts using arc, gas-shielded arc, submerged arch, or gas welding equipment. May assemble parts by bolting and riveting. May repair products by dismantling, straightening, reshaping, and reassembling parts, using cutting torch, straightening press and handtools, and be designated welder, structural repair. May specialize in using one welding process and be designated accordingly.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. According to blueprints and knowledge of welding and metallurgy, lay outs, fits, and welds fabricated, cast, and forged components to assemble structural forms.
3. Selects equipment and plans layout, assembly, and welding, applying knowledge of geometry, physical properties of metal machining, welding shrinkage, and welding techniques.
4. Lays out, positions, alines, and fits components together.
5. Sets up equipment and welds parts, using arc, gas shielded arc, submerged arc, or gas wleding equipment.

CROSS REFERENCE CHART

OCCUPATIONS/
EDUCATIONAL BLOCKS



METALLURGY

CHAPTER I

Unit 1 - History

Unit 2 - Safety

Unit 3 - Forging

Unit 4 - Introduction to trade organizations

CHAPTER II

Unit 1 - Metal's Crystalline Structure

Unit 2- Alloys

Unit 3 - Identification and selection of Iron & Steel

Unit 4 - Identification of Nonferrous Metals

CHAPTER III

Unit 1 - Fatigue

Unit 2 - Corrosion

Unit 3 - Metal Testing

Unit 4 - Rockwell & Brinell Hardness Testers

Unit 5 - Abrasives

CHAPTER IV

Unit 1 - Shop Math

Unit 2 - Geometry

Unit 3 - Lay Out

CHAPTER V

Unit 1 - Heat Treating

Unit 2 - Hardsurfacing

CHAPTER VI

Unit 1 - Powder Metallurgy

Unit 2 - Sand Casting

Unit 3 - Electrolysis

CHAPTER VII

Unit 1 - Welding I

Unit 2 - Welding II

Unit 3 - Welding III

CHAPTER VIII

Unit 1 - Machining I

Unit 2 - Machining II

Unit 3 - Machining III

Unit 4 - Machining IV

TITLE: History Educational Block I 1

NOTES: General outline of the chronological arrangement of events leading to modern times.

REFERENCES: 1. Practical Metallurgy and Materials of Industry
2. The Encyclopedia Americana

GENERAL OBJECTIVE: Introduction to field of metallurgy by a general historical presentation.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define common terms used in the history and common use of metallurgy.	Terms and Definitions Metallurgy Extractive Physical Other terms and definitions Bessemer Process Bloomery Cementation Process Direct Process Indirect Process Reduction Process Sponge Iron	2 Hours
Discuss chronological order of events in metallurgy and metals.	Major Events Bronze Age Iron Age Bellows used by Egyptians Catalon Furnace Use of Waterwheels Coke Blast Furnace Bessemer Furnace Open-hearth Furnace Electric Furnaces	3 Hours

TITLE: Safety Educational Block I 2

NOTES: 1. Safety is so broad that the instructor must limit the scope by using typical examples.
2. Safety should be covered as a separate block as well as periodically during the course and during specific tool usage.

REFERENCES: 1. American Red Cross, Basic First Aid
2. National Safety Council, posters, brochures
3. American Welding society, posters, brochures

GENERAL OBJECTIVE: Work safely using proper safety equipment and following established safety practices, procedures and OSHA standards.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Know first aid procedures	First Aid (including Burn treatment)	2 Hours
Identify first aid equipment and associate with proper usage	Safety Equipment Blankets Stretchers Fire Extinguishers First Aid Kit	2 Hours
Know basic safety hazards and practices which exist in industry	Basic Accident Prevention Safety Hazards Electrical Mechanical Chemical Heat Lifting Safety Practices Safety Equipment Glasses Hard Hats Safety Shoes Masks Tool Usage Safe Working Environment	4 Hours
Show or exhibit safety awareness and responsibility	Accidents Reports Results of not following safety rules	

TITLE: Forging Educational Block I 3

NOTES: This block may be done as a historical presentation and an exhibition or demonstration of some of the skills of a typical blacksmith.

REFERENCES:
1. Richardson, M.T. Practical Blacksmithing
2. Cooley, R.H. Complete Metalworking Manual
3. Untracht, Oppi. Metal Techniques for Craftmen

GENERAL OBJECTIVE: Discuss the operation of a forge as well as the tools and procedures of the blocksmith's profession.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define terms associated with hot-iron forging	Terms and Definitions Blacksmith Forging Metal Pig iron Wrought iron	1 Hour
Discuss tools of a forge	Tools Forge Bellows Slack Tub Hammers Cleavers Anvil Hardie Pritchel Hole Chisels Tongs Punches Files Soldering Iron Grindstone Vises Mandrils	2 Hours
Forge Usage	The Fire Clean and hot Desired temperature maintained Cutting Metal Putting a hole in metal Drawing metal Upsetting Bending Forge Welding Tempering and heat treating	4 Hours

TITLE: Introduction to trade organizations — Educational Block I 4

NOTES: This block is a presentation of some of the many organizations that exist in the metal industry.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice
2. Feirer, John L. General Metals
3. Jefferson, T. B. Metals and How to Weld Them

GENERAL OBJECTIVE: Introduce student to trade organizations, benefits to profession and methods of joining.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Identify organizations with abbreviations.	Organizations: USA - American Standards Assoc. USAS - U.S.A. Standards AISI - American Iron & Steel Institute ASTM - American Society of Testing Materials ISO - International Standards Organizations SAE - Society of Automotive Engineers AWS - American Welding Society	2 Hours
Discuss organizations and effect on career.		2 Hours

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TITLE: Metal's Crystalline Structure

Educational Block II 1

NOTE: This block presents the basic structure of metals.

REFERENCES:
1. Chanlin, Jack W. Metal Manufacturing Technology.
2. Allen, Dell K. Metallurgy Theory and Practice.
3. Neely, John. Practical Metallurgy and Materials of Industry.

GENERAL OBJECTIVE: Describe the structure of metals, the parts of an atom, the basic atomic bonding arrangements, the main lattice structures, grain structure, crystalline changes during heating, and plastic deformation.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define terms and definitions	Terms Atom Element Compound Mixture Valence electrons Valence Ion Ionic Bonding Covalent Bonding Metallic Bond Van der Waals Bond Allotronic	1 Hour
Describe the Atom	Parts Protons Neutrons Electrons Valence Symbols Bonding Arrangement	1 Hour
Distinguish between metals, metalloids, and non-metals.	Properties of a metal Crystalline structure High thermal and electrical conductivity ability to be deformed plastically metallic luster or reflectivily	2 Hours
Discuss Crystalline unit structure	6 Lattice structures Grain Structure Body-Centered Cubic Face-Centered Cubic Close-Packed Hexagonal	3 Hours

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METAL'S CRYSTALLINE STRUCTURE PAGE #2

Discuss Crystalline changes during heating	Allotropic	1 Hour
Discuss cold forming and plastic deformation	Plastic Deformation Twinning Slip lines	2 Hours

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TITLE: Alloys Educational Block II 2

NOTES: This block is presented to help the student understand concents that will be encountered later in this chapter.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Boreman, Myron L. Manufacturing Processes.
3. Chanlin, Jack W. Metal Manufacturing Technology.
4. Peirer, John L. General Metals.
5. Johnson, Carl. Metallurgy.
6. Neely, John. Practical Metallurgy and Materials of Industry.
7. Industrial Press Machinery's Handbook, 18th edition.

GENERAL OBJECTIVE: Discuss terms and definitions of metals and their alloys, the properties of a metal, and some of the methods used to identify steels.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define terms associated with alloys.	Metals Ferrous Nonferrous Alloy Solidification	1 Hour
Discuss seven properties of a metal	Hardness Brittleness Malleability Ductility Elasticity Fusibility Machinability	2 Hours
Discuss examples of ferrous alloys	Steel Low carbon steel Medium carbon steel High carbon steel Nickel steel etc.	2 Hours
Discuss method for identifying steel	See section 25 of The New American Machinist Handbook	3 Hours
Discuss examples of nonferrous alloys	Base metal Measuring Precious metals	2 Hours

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TITLE: Identification and Selection of Iron and Steel Educational Block II 3

NOTES: This block is to help a student identify and select iron and steel.

REFERENCES:
1. Neely, John. Practical Metallurgy and Materials of Industry.
2. Johnson, Carl. Metallurgy.
3. Feirer, John L. General Metals.

GENERAL OBJECTIVE: Identify and select iron and steel as well as established classifications methods.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Describe S.A.E. and A.I.S.I. systems to classify steel	Number System Prefixes	1 Hour
Discuss alloy percent and the basic types of stainless steel	Chromium Martensitic, Ferritic and Austenitic	2 Hours
Know the seven major classifications of tool steel and the assigned letter symbol.	Water hardening tool steels W-High carbon steels Shock resisting tool steels S-Medium carbon, low alloy Cold work tool steels O-Oil hardening types A-Medium alloy air hardening types D-High carbon, high chromium types Hot work tool steels H-H10 to H19, inclusive, chromium base types H20 to H39, inclusive, tungsten base types H40 to H59, inclusive, molybdenum base types High speed tool steels T-Tungsten base types M-Molybdenum base types Special purpose tool steels L-Low alloy types F-carbon tungsten types Mold Steels P-P1 to P19, inclusive,low carbon types P20 to P39, inclusive,other types	3 Hours
Know the Unified Numbering system	Fifteen series of number make up the UNS	5 Hours
Know shop tests	Inventory tag or color code Visual observation Heat or blackmill scale other surface coatings Surface complexion Fracture structure	6 Hours

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IDENTIFICATION AND SELECTION OF IRON AND STEEL

EDUCATIONAL BLOCK II 3

Know shop tests

- Magnetic Test
- Hardness Test
- Scratch Test
- File Test
- Chemical Tests
  - Surface preparation
  - Nitric acid in methanol
  - 10% solution of nitric acid
  - Copper sulfate
  - Sulfuric acid
  - Hydrochloric acid
- Spark Testing
- Machinability Test

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TITLE: Identification of Nonferrous Metals Educational Block: II 4

NOTES: This block completes chapter II and enlarges the student's ability to identify metals.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Feirer, John L. General Metals.
3. Johnson, Carl. Metallurgy.
4. Neely, John. Practical Metallurgy and Materials of Industry.

GENERAL OBJECTIVE: Know the numbering system for aluminum, the characteristics of nonferrous metals, and use the specific gravity of a metal for identification.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
By figuring the specific gravity of an unknown identify the metal	Volume and density Archimedes Principle	3 Hours
Discuss types of numerical systems used to identify aluminum	Federal Specifications Military Specifications The A.S.T.M. The S.A.E. The adopted Aluminum Association of 1054 system	4 Hours
Identify characteristics of nonferrous metals	Aluminum Cadnium Copper Brass Bronze Lead Magnesium Molybdenum Nickel Gold Silver Platinum Iridium Tantalum Tin Titanium Tungsten Zinc Zirconium	4 Hours

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TITLE: Fatigue

Educational Block III 1

NOTES: This is the first of two blocks that deal with metal failure.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Bereman, Myron L. Manufacturing Processes.
3. Claussen, G.E. Welding Metallurgy.

GENERAL OBJECTIVES: The student should be able to discuss the nature of fatigue, identify the causes of a failure, and the methods to prevent the occurance of the condition.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Identify and explain terms associated with fatigue.	Fatigue Strength Fatigue Limit or endurance limit Fatigue Failure	1 Hour
Identify signs of poor design	Excessive deformation around fracture	1 Hour
Discuss fracture conclusions	Hard zones Bi-Axial or multi-axial stress	1 Hour
Explain the importance of surface condition	Rough specimen Polishing Hardening Shot-peening	2 Hours
Describe How failure starts	Cracks Scratches Tool Marks Cross-sectional changes Undercutting	2 Hours
Discuss three fatigue tests	Vibrating beam test Tension Compression fatigue test Rotating beam test	2 Hours
Explain endurance limit		1 Hour

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TITLE: Corrosion Educational Block III 2

NOTES: This block covers the other type ofmetal failure, corrosion.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Begeman, Myron L. Manufacturing Processes.
3. Claussen, G.E. Welding Metallurgy.

GENERAL OBJECTIVE: Describe the process of corrosion, establish corrosion tests, identify areas suscentible to corrosion and use methods to avoid corrosion.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline		Recommended Time
Define terms commonly used in corrosion	Corrosion Oxidation Galvanic Action Interranular corrosion		1 Hour
Identify areas susceptible to corrosion and identify the signs of corrosion.	Joining of two unlike metals Stress and fatigue Acids Cracks and crevices Oxidation Blue-green for copper Black for lead White or gray for aluminum or zinc Reddish/brown for most steel Water Distilled water-least corrosive Fresh water Sea water-most corrosive Galvanic Action Electric current Anode is always the corroded metal Interranular Corrosion		2 Hours
Describe and Discuss an electrochemical series for metals	Potassium Sodium Calcium Magnesium Aluminum Manganses Zinc Iron Nickel Lead Tin Hydrogen Copper Mercury Silver Platinum Gold	Corrosive Resistive	1 Hour

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Describe methods to prevent corrosion	High purity metal	1 Hour
	Corrosion-resistant metal	
	Corrosion-resistant alloys	
	Silicon	
	Aluminum	
	Copper	
	Nickel	
	Tin	
	Zinc	
	Lead	
	Precious metals	
Describe corrosion tests	Measured	4 Hours
	Lost tensile strength	
	Lost weight	
	Gain weight	
	Tests should relate to service	
	Salt Spray (Fog) test	
	Alternate Immersion Test	
	Total Immersion Test	
	Boiling Nitric Acid Test	
	Strauss Solution Test	
	Mercurous Nitrate Test	

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TITLE: Metal Testing Educational Block III 3

NOTES: This short block is a listing of tests that did not seem to fit elsewhere. An instructor may want to do this unit concurrently with unit III 2.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Feirer, John L. General Metals.
3. Neely, John. Practical Metallurgy and Materials of Industry.

GENERAL OBJECTIVE: Be able to perform tests on metals.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Identify and describe metal test as to their purpose and objective	Tests Microscopic Tests Fracture Tests Macro-Etching Tests Magnetic Testing Sperry Test Magnaflux Radiography Tests Ultrasonic Hardness Test Liquid Penetrant Eddy Current Temperature	4 Hours

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TITLE: Rockwell & Brinell Hardness Testers Educational Block III 4

NOTES: This block does not depend on the expenditure for the Rockwell & Brinell Hardness Testing machines. The theory that the machines use is the important idea.

REFERENCES: 1. Chaplin, Jack W. Metal Manufacturing Technology.
2. Allen, Dell K. Metallurgy Theory and Practice.

GENERAL OBJECTIVE: Discuss the principles and procedures of the Rockwell and Brinell Hardness Testers.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define hardness testing terms	Terms Hardness of a metal Penetration hardness Minor Load Major Load kgf - Kilograms of force	1 Hour
List ways hardness is measured.	Resistance to penetration Elastic hardness Resistance to abrasion	1 Hour
Discuss surface preparation and proper use	Rough surface should be curved surface should have flat spot ground Tubing must be supported on the inside Overhand must be supported Keep penetrator at least 1/8 inch from edge Calibration check daily	1 Hour
Explain Rockwell Hardness Tester and the Brinell Hardness Tester	Loads Minor Major Depth of Penetration Penetrators Brale-a sphero-conical diamond 1/16 inch steel ball Anvils Scales	2 Hours
Explain superficial testing	Penetrator Impression on underside of specimen Case hardened and nitrided steel with thin case	1 Hour

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TITLE: Abrasives Educational Block III 5

NOTES: This entire block or part could be used at the end of chapter VI to finish the projects of those units.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Begeman, Myron L. Manufacturing Processes.
3. Chaplin, Jack W. Metal Manufacturing Technology.

GENERAL OBJECTIVES: Use an abrasive wheel throughout the metal finishing operation using proper safety procedure, discuss the procedures of each operation, and true and dress a grinder wheel.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define abrasive terms	Grinding Abrasive Polishing Buffing Offhand	1 hour
Identify and discuss abrasive operations	Grinding Polishing Buffing	1 hour
Discuss types of abrasive materials	Natural Emery Corandum Artificial Silican carbide Aluminum oxide	1 hour
Discuss grain size	Process Furnace Mine Screens Numerical desimation	1 hour
Identify and discuss safety measures	Goggles Toolrest spacing - 1/16 to 1/8 inch Correct type of wheel Proper side of wheel Wheel properly dressed	2 hours
Describe Grinding wheels	Grades (Grits) Shape Sizes Bonding into shape Soft metals - numbers 36 to 46 Hard metals - Numbers 60 to 80	2 hours

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ABRASIVES

EDUCATIONAL BLOCK III 5

Describe effect of use	Loaded Wheel Glazed wheel Work wheel	1 Hour
Discuss and preform the dressing and truing of a wheel	Dressing Disk-tyne dresser Abrasive stick Diamond tip Truing	2 Hours
Discuss and perform the grinding operation.		2 hours
Discuss and perform the polishing operation		2 hours
Discuss and perform the buffing operation		2 hours

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TITLE: Shop Math Educational Block: IV 1

NOTES: This unit is included to help the instructor spot student's problem areas.

REFERENCES: 1. Feirer, John L. Machine Tool Metalworking.

GENERAL OBJECTIVE: Be able to preform simple math.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Perform basic math	Addition Substraction Multiplication Division Change fractions to decimals Change decimals to fractions Add fractions and decimals Substract fractions and decimals	3 Hour

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TITLE: Geometry Educational Block: IV ?

NOTES: This block is included to help a student develop common geometrical shapes.

REFERENCES: 1. Van Nostrand. Geometry for the Practical Man.
2. Pavielli, Anthony. An Adventure in Geometry.

GENERAL OBJECTIVE: Be able to discuss terms, definitions and basics of geometry as well as draw basic shapes.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define common terms, definitions, recognize shapes, and be able to draw.	Symmetry Point Motion of Line Horizontal Vertical Oblique Straight Curved Parallel Motion of Surface Angle Acute Right Obtuse Vertex Side Polygon Octagon Heptagon Hexagon Pentagon Quadrilateral Square Rectangle Triangle Circle Radius Diameter Chord Segment Tangent Arc Cube Pyramid Cylinder Cone Ellipse Parabola Hyperbole Sphere Helix Spiral of Archimedes	8 Hours

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EDUCATIONAL BLOCK : IV 2

SUGGESTED PROCEDURE:

1. Definitions:

Symmetry - Correspondence of opposite parts in size, shape, and position. Excellence of form or balance resulting from this.

Point - A point does not occupy space. It is indivisible, having neither length, width, nor thickness. It indicates nothing more than a position in space.

Line - A line is the extension of a point; it has neither width nor thickness only length. Lines are as abstract as the moving points that describe them.

Horizontal Line - is a line that runs from left to right and is parallel to the surface of water at rest.

Vertical Line - is a line that runs straight up and down and is at right angles to a horizontal line.

Oblique Line - is one that is neither vertical nor horizontal.

Straight Line - is the shortest distance between two points.

Curved Line - is one that is constantly changing its direction.

Parallel Lines - are straight lines which lie in the same plane and never meet, however far they are extended.

Motion of a point - The motion of a point produces a line.

Surface - A surface is produced by the motion of a line. A surface has two dimensions: Length and Width.

Angle - An angle is the figure formed by two lines drawn from the same point.

Acute angle - is an angle less than a right angle.

Right angle - is formed by one straight line meeting another is such a way that the two adjacent angles are equal. Both angles are then right angles.

Obtuse angle - is an angle greater than a right angle.

Vertex - the common point of the angle.

Side - the two lines of an angle.

Polygon - a plane figure with several angles and sides, usually more than four.

Motion of a line - the motion of a line produces a surface.

Octagon - A plane figure with eight angles and eight sides.

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Heptagon - A plane figure with seven angles and seven sides.

Hexagon - A plane figure with six angles and six sides.

Pentagon - A plane figure with five angles and five sides.

Quadrilateral - is a polygon of four sides.

Square - is a rectangle having four equal sides.

Rectangle - is a parallelogram with all of its angles right angles.

Triangle - is a polygon of three sides.

Circle - is a plane figure bounded by a curved line (called the circumference), every point of which is equally distant from a point within called the center.

Radius - A radius of a circle is a straight line drawn from the center to any point on the circumference.

Diameter - The diameter of a circle is that chord which passes through the center of the circle.

Chord - is a straight line joining any two points on the circumference.

Segment - is the area included within a chord and its arc.

Tangent - A straight line having one, and only one, point in common with a circle is said to be tangent to the circle.

Arc - is any portion of the circumference of a circle.

Cube - is a right parallelopiped all of whose faces are squares.

Pyramid - is a polyhedron whose base is a polygon of any number of sides and whose lateral faces are triangles having a common vertex.

Cylinder - is the figure formed by the rotation of a rectangle about one side which remains stationary as an axis.

Cone - is a solid figure tapering uniformly from a circular base to a point called the vertex.

Ellipse - A plane intersecting a right circular cylinder not parallel to its base forms an ellipse at the intersection.

Parabola - A plane curve formed by the intersection of a cone with a plane parallel to its side.

Hyperbole - A curve formed by the section of a cone cut by a plane more steeply inclined to the base than to the side of the cone.

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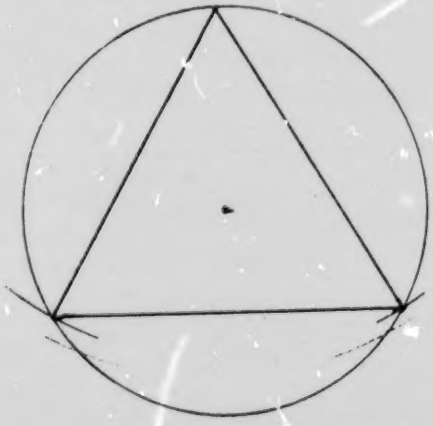
Sphere - is a solid bounded by a curved surface, every point of which is equally distant from a point within called the center.

Helix - a line curved like a wire that has been wound around a cylinder. Three dimensions

Spiral of Archimedes - The mark left by the attempt to draw a straight line on a revolving disk. Two dimensions.

2. Inscription of regular polygons in circles.



EQUILATERAL TRIANGLE

S = Side of Triangle

R = Radius

$S = R\sqrt{3}$

R = 3 CM

$S = 3\sqrt{3}$

S = 5.2 CM

Polygons of 6, 12, 24, 48, etc. can be drawn, using this method, by repeated bi-section of the side and can be accomplished by either compass or mathematical division.

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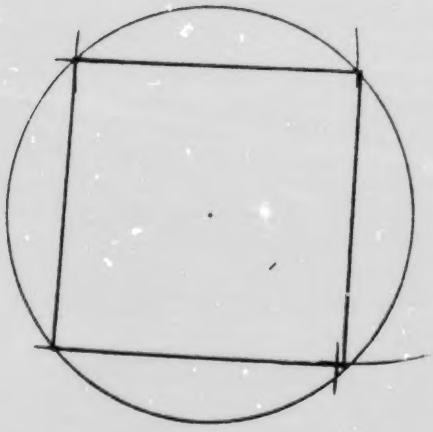


Square

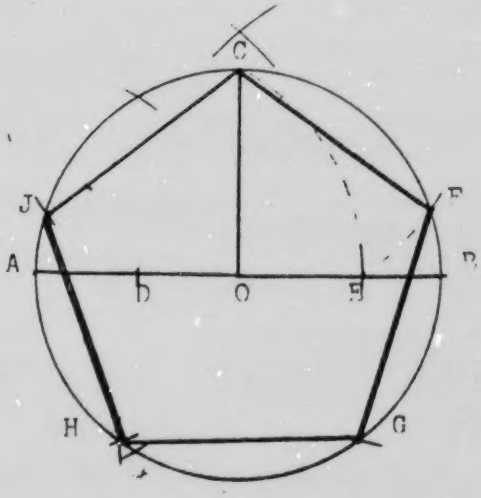
$S = R\sqrt{2}$

$R = 3$

$S = 3\sqrt{2} = \#\ (1.414)$

$S = 4.24$

#Precise measurement is critical in using these methods.



Pentagon

Draw a diameter AB and at O erect OC ⊥ AB. Bisect the radius at D and with center D and radius DC lay off DE = DC. Then with center C and radius CE draw the arc EF, intersecting the circle at F, and draw the chord CF. CF is then a

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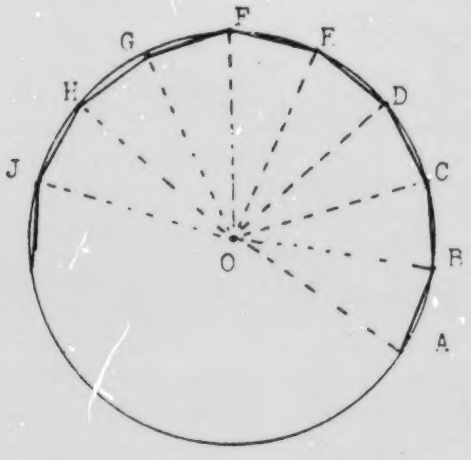
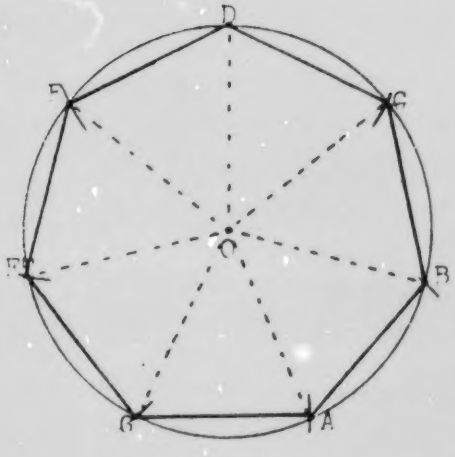
side of the required regular pentagon, and by applying CF five times as a chord, as at CF, FG, GH, HJ, VC, the pentagon is obtained.



Polygon of n-sides, where n can represent any number greater than 3

$\frac{360}{n}$ = the number of degrees of the interior angle
Example: AOB

and the length of the side of the polygon can be determined mathematically.



Pentagon

Example:

$\frac{360}{7} = 51.4286$

A = 3, b = 3, C = 51.4286

$c = \sqrt{a^2 + b^2 - 2ab \cos C}$

$= \sqrt{9 + 9 - 18 \cos 51.4286}$

$= \sqrt{6.777}$

= 2.60 cm

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TITLE: Layout — Educational Block IV 3

NOTES: Adequate work requires proper layout procedures for economical as well as expedient proformance. Layout work varies considerably and no hard-and-fast rules can be given for this procedure. The directions here are only suggestive and need not be followed in the sequence mentioned.

REFERENCES:
1. Wagener, Albert M. Machine Shop Theory and Practice.
2. Giachino, J.W. Basic Bench-Metal Practice.
3. Feirer, John L. Machine Tool Metalworking.

GENERAL OBJECTIVES: From a blueprint or working drawing, make a project layout.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Identify and define tools and their uses.	Tools Rules Caliners Slide Inside Outside Divider Hermaphrodite Squares Corbination Double Try Bevel Protractors Bevel Vernier Punch Hammers Compass	2 Hour
Identify coloring materials	Blackboard chalk Layout die Blue vitriol Alcohol/chalk powder mixture	2 Hour
Layout procedure	Prepare the surface Remove burrs Square the ends of stock Clean Establish base line Seat the work Draw center lines Scribe straight lines Draw angular lines Draw all arcs Draw lines to indicate the internal area to be removed Locate centers of holes Draw bending lines	4 Hour

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TITLE: Heat Treating Educational Block V 1

NOTES: The block on forging may be refered to in dealing with this unit.

REFERENCES:
1. Claussen, G.E. Welding Metallurgy.
2. Gincho, J.W. Welding Technology.
3. Johnson, Carl. Metallurgy.

GENERAL OBJECTIVES: Be able to properly heat treat steel, discuss the various heat treating processer, the change in the metal, and the reasons for heat treating.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define common terms associated with heat treating.	Terms and definitions Annealing Full Annealing Stress Annealing Process Annealing Recrystallization Critical Strain Grain Growth Spheroidizing Normalizing	2 Hour
List and discuss dependency of recrystallization temperature	Degree of prior coldwork Annealing time Grain size Metal purity	1 Hour
Describe the stages of heat treating	Recovery Recrystallization Grain growth	1 Hour
Discuss and exhibit the steps of heat treating	Heat to proper temperature Holding or sealing at proper temperature Controlled cooling	3 Hour
Know and discuss heat treating processes	Stress Relief Spheroidizing Normalizing Annealing	5 Hour

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TITLE: Hardsurfacing

Educational Block: V 2

NOTES: The process of fusion welding is mentioned at this time. A more detailed explaination of the process could be discussed during the block on welding.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Begeman, Myron L. Manufacturing Technology.
3. Charlin, Jack W. Metal Manufacturing Technology.
4. Claussen, G.E. Welding Metallurgy.
5. Johnson, Carl. Metallurgy.

GENERAL OBJECTIVE: Be able to determine proper method to hardsurface an article as well as discussing hardsurfacing methods and advantages.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define hardsurfacing		1 Hour
List and discuss the hardsurfacing methods, advantages and disadvantages	Heat treatment	7 Hour
	Carburizing	
	Solids	
	Liquids	
	Gases	
	Special case-hardening processes	
	Nitriding	
	Chapmanizing	
	Dry cyaniding	
	Ni-carbing	
	Induction hardening	
	Flame hardening	
	Process	
	Methods	
	Stationary	
	Progressive	
	Rotating	
	Metal spraying	
	Metal plating	
	Fusion welding	
	Overlay	
	Diamond substituter	
	Casting or spinning	
Discuss classifications of hardsurfacing materials	Overlay	1 Hour
	Diamond substitutes	

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TITLE: Powder Metallurgy — Educational Block VI 1

NOTES: This block, as well as this chapter, can be included in the course at most any point after the metallurgy basics, the first three chapters, are covered.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Peterman, Myron L. Manufacturing Processes.
3. Neely, John. Practical Metallurgy and Materials of Industry.

GENERAL OBJECTIVES: Be able to discuss procedures, advantages, and disadvantages of powder metallurgy, as well as exhibit this process.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define common terms associated with powder metallurgy	Pressure Welding Green Strength Briquetting or Cold Welding Lubricants Sintering	2 Hour
Discuss metallic powder manufacturing methods	Mechanical Shotting Granulation Atomization Vapor Condensation Carbonyl Oxide Reduction Electrolytic Deposition Chemical Precipitation	1 Hour
Describe distinguishing characteristics of powders	Particle size Particle shape Surface profile Nature Internal grain size Lattice distortion Impurities	1 Hour
Discuss powder classifications	Chemical composition Physical structure Flow characteristics Apparent Density	2 Hour
Discuss factors affecting press design	Powder mix Die fill depth Pressures employed Production rate Abrasive nature of powder Need of lubricant Volume change Repressing	2 Hour

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POWDER METALLURGY PAGE #2

EDUCATIONAL BLOCK VI 1

Discuss hot pressing problems	Powder Oxidation	2 Hour
	Die wear	
	Temperature resistance	
	Heating methods	
	Temperature control	
	Pressures	
	Annealing	
Discuss advantages	Combination of special metals	1 Hour
	Controlled density	
	Economy	

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TITLE: Sand Casting

Educational Block: VI 2

NOTES: This block, as well as this chapter, can be included in the course at most any point after the metallurgy basics, the first three chapters, are covered.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Begeman, Myron L. Manufacturing Processes.
3. Neely, John. Practical Metallurgy and Materials of Industry.

GENERAL OBJECTIVES: Be able to discuss all aspects of sand casting as well as design and cast a project.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended topical Outline	Recommended Time
Define terms associated with sand casting	Bench molding Floor molding Pit molding Machine molding Jolt machine Squeeze machine Sand slingers	1 Hour
Discuss major concerns when metal casting	Controlling grain size Reducing porosity Compensating for shrinkage or expansion	1 Hour
Describe beneficial properties	Neither laminated or segrated Uni-directional strength Even wearing	1 Hour
Describe cast-iron properties	Dampens vibration Rigid Machinability	1 Hour
Discuss pattern allowances	Draft Shrinkage or expansion Distortion Machining	1 Hour
Describe sand mold characteristics	Strength of mold Corrosion resistance Gas passage Minimumal gas reaction Temperature resistance Ease of cleaning Pressure resistance	2 Hour

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TITLE: Electrolysis Educational Block: VI 3

NOTES: This block, as well as this chapter, can be included in the course at most any point after the metallurgy basics, the first three chapters, are covered.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Begeman, Myron L. Manufacturing Processes.
3. Neely, John. Practical Metallurgy and Materials of Industry.

GENERAL OBJECTIVES: Be able to discuss the procedure of electrolysis and perform a project.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Describe the principle of electroplating	Cathode Anode Metal Bath	2 Hour
Explain the electroplating procedure	Equipment and Materials Power supply Tanks Annodes Plating solution Preparation of metal Current Design considerations Finishing	4 Hour

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TITLE: Welding I — Educational Block VII 1

NOTES: The time allotted will need to be altered for student participation.

REFERENCES: Ludwig, Oswald A. Metalwork Technology and Practice.

GENERAL OBJECTIVE: Properly perform both arc and oxy-acetylene welding.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Describe the theory of the oxyacetylene welding process; set up pressurize, test, light, extinguish and drain system.	Set up Equipment Tanks Generators Safety Regulate Pressure	1 Hour
Cut mild steel with oxyacetylene equipment	Cut Flat stock Angle iron Side wall boiler tubes	1 Hour
Describe brazing and determine when it is appropriate to use.	Brazing and braze welding	2 Hour
Describe fusion welding and recommend appropriate application	Fusion Welding	2 Hour
Braze using oxyacetylene and carbon arc equipment in the down hand position.	The Carbon Arc Process Weld Flat Stock Steel Horizontal Vertical Corner Weld Lap Weld Edge Weld Patch holes Braze Copper Tubes Braze Cast Iron Silver Solder	6-8 Hour
Describe the theory of the arc-welding process and set up welder for various welding jobs, selecting proper filler	Arc Welding Techniques Set up equipment AC DC Safety Regulate Machines Prepare Work Cut-Bevel Clean Weld Single-Bend-Flat Fillet Weld Butt Weld Lap Weld Vertical Build up cast iron and steel Overlay and lace bead Horizontal T and fillet Low Pressure piping	10 Hour

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EDUCATIONAL BLOCK VII 1

Describe the eneven expansion and contraction of metals and recommend practices to offset this phenomenon.	Pre-heating Spot welding	2 Hour
Cut with Torch	Oxy-Acetylene Torch Use Cutting Tip	4 Hour

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TITLE: Welding II Educational Block VII 2

NOTES: Time allotted will need to be adjusted for student participation.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Johnson, Carl. G. Metallurgy.
3. Jefferson, T.B. Metals and How to Weld Them.
4. Henry, O.H. Welding Metallurgy.

GENERAL OBJECTIVE: Know welding rod classification systems and the use of as many of the welding systems as possible.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Know mild-steel electrode classification system	Prefix Digit number system Electrodes	6 Hour
Know alloy-steel electrode classification system	Prefix Digit number system Electrodes	4 Hour
Know stainless-steel electrode classification system	Prefix Digit number system Electrodes	4 Hour
Know special electrode classification	Prefix Digit number system Electrodes	4 Hour
Know submerged-arc welding electrodes and fluxes	Manufacturer's recommendations	3 Hour
Know gas welding rod specifications	Specifications Rods	3 Hour
Know welding systems	Arc Welding Atomic hydrogen Bare metal Carbon Flux/cored Gas metal Gas tungsten Plasma Shielded metal Submerged Oxyfuel Gas Welding Air acetylene oxyacetylene oxyhedrogen pressure gas Resistance Welding Flash welding High frequency Percussion Projection Resistance seam Resistance spot Unset	20 Hour

Solid State Welding
- Cold
- Diffusion
- Explosion
- Forge
- Friction
- Hot pressure
- Roll
- Ultrasonic

Other Welding
- Electron beam
- Electroslag
- Flow
- Induction
- Lazer beam
- Thermit

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TITLE: Welding III — Educational Block VII 3

NOTES: Time allotted will need to be adjusted for student participation.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Jefferson, T.B. Metals and How to Weld Them.
3. Henry, O.H. Welding Metallurgy.

GENERAL OBJECTIVE: Know the effects of welding, how to weld low-carbon steel, medium-carbon steel, high carbon steel, alloy steels, cast iron, stainless steels, high-chromium alloys, manganese steel non-ferrous metals, tool and die steels, and the exotic metals.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Know welding thermal events	Heating the metal Manipulation of weld deposite Cooling Reheating for stress-relief, if necessary	1 Hour
Know how to weld low carbon steel	Welding precesses Procedure Basic recommendations	2 Hour
Know how to weld medium carbon steel	Welding processes Procedure Recommendations	3 Hour
Know how to weld high-carbon steel	Welding processes Procedure Recommendations	3 Hour
Know how to weld alloy steels	Welding processes Procedure Recommendations	3 Hour
Know how to weld cast iron	Welding processes Procedure Recommendations	3 Hour
Know how to weld stainless steel	Welding processes Procedure Recommendations	3 Hour
Know how to weld high chromium steels	Welding processes Procedures Recommendations	3 Hour

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TITLE: Machining I — Educational Block VIII 1

NOTES: Although designed for the machinist, this block is an introduction to machining and can be used to acquaint non-machinist to this field.

REFERENCES: 1. Feirer, John L. General Metals.
2. Allen, Dell K. Metallurgy Theory and Practice.

GENERAL OBJECTIVE: The student should be able to discuss the complexities of machining.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Define common terms and definitions	Efficiency Machinability Machine Variables Material Variables	1 Hour
Explain and list the variables involved	Machine Variables Cutting speed Depth of cut Tool material Tool geometry Nature of cut Environment Material Variables Hardness Tensile strength Alloy composition Microstructure Previous cold work Strain Hardenability Shape and dimension Rigidity of workpiece	2 Hour
Explain the physics of metal cutting	Basic types of chips Discontinuous or segmental Continuous Continuous with built-up edge Hardening from metal cutting Forces acting on cutting tool	2 Hour
Discuss the metallurgical factors that determine machinability	Chemical composition Processing treatments Physical characteristics	2 Hour
Explain the selection of cutting tools	Cutting forces Cutting temperatures Tool wear	2 Hour

MACHINING I

EDUCATIONAL BLOCK VIII 1

State the basic forms of metal cutting	Turning Milling Drilling Hole Reaming Surface Cutting Grinding and Lapping Bank Machining Broaching Countersinking and counterboring	1 Hour

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TITLE: Machining II — Educational Block VIII 2

NOTES: In this block the machinist studies the machines.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Feirer, John L. General Metals.
3. Feirer, John L. Machine Tool Metalworking.
4. Giachino, J.W. Basic Bench-Metal Practice.

GENERAL OBJECTIVE: Be able to safely operate the machines.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Know safety rules and procedures for operating the machines	Working position Clothing Other factors	2 Hour
Know lathe operation	Engine lathe Turret lathe Screw Machine Tracer lathe	8 Hour
Know milling machine	Column-and-knee Horizontal Vertical Profiler	6 Hour
Know drilling machine	Drill press Radial drill Multiple-spindle Turret Tapping Reaming	6 Hour
Know hole boring	Boring Machine Horizontal Vertical	5 Hour
Know surface cutting	Shaper Planer Slotter	4 Hour
Know grinding and lapping	Grinding Lapping	3 Hour
Know band machining	Horizontal Vertical	3 Hour
Know broaching	Push-type Pull-type	3 Hour
Know countersinking and counterboring	Countersinking Counterboring	2 Hour
Know how to cut gears	Milling Machine Hobbing Machine	2 Hour

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TITLE: Machinery III — Educational Block VIII 3

NOTES: This block is a continuation of the machinist study and covers taps and dies.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Giachino, J.W. Basic Bench-Metal Practice.
3. Warener, Albert M. Machine Shop Theory and Practice.

GENERAL OBJECTIVE: Identify and cut threads and taps.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

After completion of this block, the student will:	Recommended Topical Outline	Recommended Time
Identify and define terms	Threads Right-hand Left-hand Pitch Crest or point Root Depth Major Diameter Minor Diameter Pitch Diameter Clearance Threads per inch American National Sharp V Square Thread Acme National Fine Fits Loose Free Medium Close Taps Land Heel Flute Cutting face Thread Relief (Radial) Chamfer Shank diameter Taper Plug Bottoming Machine Screw National Coarse National Fine Pipe Tap Wrenches Drills Lubricants	5 Hour

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MACHINERY III

EDUCATIONAL BLOCK VIII 3

Be able to cut inside threads	Tapping a hole Select the tap Drill the hole Start the tap Cut the threads	2 Hour
Be able to cut outside threads on a rod	Prepare the rod Select the correct die Adjust the die Cut the threads Reverse the die if necessary Check the threads	2 Hour
Be able to cut pipe thread with a die	Prepare the pipe Select the correct die Adjust the pipe die Cut the threads Test the threads	2 Hour

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TITLE: Machining IV Educational Block VIII 4

NOTES: This educational block prepares the student for the advent of special metals in industrial use.

REFERENCES:
1. Allen, Dell K. Metallurgy Theory and Practice.
2. Johnson, Carl. G. Metallurgy.
3. Charlin, Jack W. Metal Manufacturing Technology.

GENERAL OBJECTIVE: Be able to machine special metals by knowing its characteristics.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

Upon completion of this block, the student will:	Recommended Topical Outline	Recommended Time
State the machining characteristics and be able to obtain the necessary requirements to machine the following metals and alloys safely.	Maganese Steel Tungsten Steel Molybdenum Steel Vanadium Steel Silicon Steel Magnesium[1] Niobium (Columbium) Beryllium [2] Titanium Molybdenum Tantalum Tungsten Zirconium [1] Indium	14 Hour

[1]Due to its high affinity for oxygen, magnesium and zirconium are highly flammable.

[2]The dusts, fumes, or vapors produced by processing beryllium are toxic when inhaled.

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BIBLIOGRAPHY

Allen, Dell K. Metallurgy Theory and Practice. American Technical Publishers, Inc. 1981.

Allen, Dell K. Mortensen, Kay S. Metallurgy and Materials Science Laboratory Manual. American Technical Society, 1973.

Arthur, Harlan R. Albert M. Wagener. Machine Shop Theory & Practice. Second Edition. D. Van Nostrand Company, Inc., 1950.

Ashkouti, Joseph, A. Aircraft Mechanic's Pocket Manual. Pitman Publishing Corp. Second Edition, 1942.

Begeman, Myron L. Manufacturing Processes. John Wiley and Sons, Inc. Second Edition, 1947.

Benton, William, Helen Benton. Encyclopedia Britannica. Encyclopedia Britannica, Inc., 1974.

Chaplin, Jack W. Metal Manufacturing Technology. McKnight Publishing Company, 1976.

Claussen, G.E. O.H. Henry. Welding Metallurgy. The American Welding Society, 1940.

Compton's Encyclopedia. F.E. Compton Company, Division of Encyclopedia, Inc., 1975.

Feirer, John L. J.W. Giachino. Basic Bench-Metal Practice and Precision Measuring. Charles A. Bennet Company, Inc. 1943.

Feirer, John L. General Metals. McGraw-Hill Book Company, Fourth Edition, 1974.

Feirer, John L. Earl E. Tatro. Machine Tool Metalworking. McGraw-Hill Book Company, Inc. 1961.

German, Carl, Jr. A Guide For Planning Facilities for Occupational Preparation Programs in Metallurgy Technology. The Center For Vocational and Technical Education, 1969.

Giacho, J.W. W. Weeks, G.S. Johnson. Welding Technology. American Technical Society, Second Edition, 1973.

Jefferson, T.B. Gorham Woods. Metals and How to Weld Them. The James F. Lincoln Arch Welding Foundation, Second Edition, 1962.

Johnson, Carl, G. William R. Weeks. Metallurgy. American Technical Publishers, Inc. Fifth Edition, 1977.

Jones, F.D. Erik Oberg. Machinery's Handbook. The Industrial Press, Eleventh Edition, 1942.

Metallurgical Technology. U.S. Department of Health, Education, and Welfare, 1968.

Metallurgy and Metals Properties. Technical Education Research Center, Inc., 1977.

Neely, John. Practical Metallurgy and Materials of Industry. John Wiley & Sons, Inc., 1979.

Neely, John, Instructor's Manual - Practical Metallurgy and Materials of Industry.

Procedure Handbook of Arc Welding Design and Practice. The Lincoln Electric Company, Seventh Edition, 1942.

Ravielli, Anthony. An Adventure in Geometry. The Viking Press, New York, 1957.

Richardson, M.T. Practical Blacksmithing. Weathervane Books, New York, 1978.

Saunier, Claudius. The Watchmaker's Hand Book. Hazlitt and Walker, 1903.

The Encyclopedia Americana. Americana Corp. 1971.

The New Book of Knowledge. Grolier, Inc. 1976.

Untracht, Oppi. Metal Techniques for Craftsmen. Doubleday & Company, Inc., 1968.

Wigginton, Eliot. Foxfire 5. Ironmaking, Blacksmithing, Flintlock rifles, Bear Hunting, and other affairs of plain living. Anchor Books, Anchor Press Doubleday, 1979.

Zim, Herbert S. Ph. D. Our Wonderful World. Grolier, Inc. 1966.

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Preface

Shell Oil, who is the construction contractor for the Sparta mine, lists six basic functions that will be continually in operation once the operation begins.

An average of 85 acres per year will be cleared of trees, brush, and other vegetation. The large trees will be harvested for lumber and pulp processing. Most of this initial operation will be accomplished by the timber industry. The smaller trees and brush will be shredded for use as mulching material on the reclaimed land and will be a part of the mining operation. Following behind these will be crawler dozers equipped with rippers to loosen the topsoil for the next operation.

The topsoil material will be removed and initially stockpiled for reclamation. Once mining has advance sufficiently the topsoil removal and replacement cycle will become one continuous operation. The equipment used in topsoil removal and replacement will include crawler dozers and twin-engine scrappers.

The third function at the Sparta Mine will be the removal of the overburden material and will represent the single most important and costly operation. The current plans for this operation call for the use of large walking draglines, bucket wheel excavators, and twin-engine scrapers to remove and replace the overburden.

The lignite will be removed by front-end loaders and hydraulic backhoes. This coal will be loaded into large bottom-dump coal trucks (a capacity of approximately 120 tons) for hauling to the facilities site.

The lignite will be dumped from the trucks into a crusher for reduction to a specified size. Conveyors will then transport the lignite to a central stockpile area, where it will be blended, weighed , and sampled prior to delivery to the power plant.

The sixth and final function at the Sparta Mine is the reclamation of the mined land, which is a multi-step process. First, dozers and graders will grade the mine spoil to approximately the original contour. The topsoil will then be replaced as a part of the continuous topsoil handling operation as discussed previously. Modern agricultural equipment will be used to establish and manage revegetation activities in restoring premining productivity levels to the mined land.

Several support functions that will be vital to the sucessful operation of the mine include the following: road maintenance, which will involve graders, rubber tired dozers, small dump trucks, front-end loaders, and water trucks; ditch and pond construction, using dozers, scrapers, and compaction equipment; water control, which includes pumps and the construction of water control structures; and maintenance to the mobile equipment, surface facilities, and the electrical equipment.

This field, heavy equipment, is taught at three of Arkansas' Vocational schools: Petit Jean in Morrilton, Twin Lakes at Harrison, and Red River at Hope. Each school has attempted to conform to a standard method of instructing the curriculum. And, the instructors are accomplishing an outstanding job considering the limited ability in many cases of a single instructor to safely supervise several students from a distance who are operating as many as six machines each weighing well in excess

of three tons with the capability to go through most any type of building. So, it is obvious that these instructors are very capable and knowledgeable concerning their field.

The text that these instructors use is Moving the Earth by Herbert L. Nichols, Jr. This text does cover the gamut of heavy equipment operation. Due to the foresight in using this text in the classroom these vocational schools are preparing their students for most any type of operation they may experience during their career in this field.

These vocational schools do have different time frames. Morrilton uses a twenty week or six month period only. Harrison has a six month and an advanced student program covering twelve months. Hope uses twenty-three weeks or nine months.

Each school does teach a slightly different type of equipment. Morrilton teaches the bulldozer, motor patrol, front-end loader and the self-propelled scrapper, which is currently not in service. Harrison teaches the bulldozer, motor partol, self-propelled and pull scrappers, front end loaders and to a limited degree the backhoe. Hope teaches the bulldozer, the scrapper, the motor patrol, and the backhoe.

Occupations

Between the pages 127 to 139 are listings from the Dictionary of Occupational Titles that are applicable to this field. Determining the training of secondary students in this field would possibly need to be limited for the safety of all concerned. The majority of the equipment of this field is just too powerful and dangerous. However, a secondary program could be developed that could cover mine safety training along with the stationary machines of heavy equipment, like the compressor, it's attachments, water pumps, and, possibly the basic information from chapter twelve of Moving the Earth, which is the beginning of the post-secondary curriculum.

Entry Level Skills

Kentucky is currently completing a required 24 hour program on mine safety. It covers thirteen areas of study which include: instruction in the statutory rights of miners and their representatives, self-rescue and respiratory devices, transportation control and communication systems, introduction to work environment, escape and emergency evacuation plans, ground control, health hazard recognition, electrical hazards, first aid, explosives which is not supposed to be used at the Sparta mine, health and safety aspects of tasks to which the new miner will be assigned, and such other courses that the Training Center Chief may require for a particular mine.

This program is excellent and could easily be adapted by a secondary vo-tech to expedite mine personal when the Sparta mine begins. Or, the post-secondaries could add this program onto their curriculum. Either

way would work out fine. However, the majority of the participants of a course like this would be adults. Therefore, the secondary would have to establish a special course were it to try to teach this program.

Program

An alteration to the present heavy equipment program seems to be unncessary and counter-productive. Currently, the instructors are fully covering the field with a more than adequate text, audio-visual material, plenty of practical application when the equipment permits and properly accounting for the students ability with a comprehensive diploma.

If the secondary vocational schools want to enter this field, it would seem that the best place for them is the basic of heavy machinery, safety, and the miscellaneous stationary equipment. Not only does this save the secondaries money that would have to be expended on the equipment, it creates a safer program.

The presentation of a complete curriculum may be helpful. This is the one used by Hope. And they use twenty-three weeks to cover their material. Please refer to page 140 for an outline for the heavy equipment course. However, a person must be aware that this course is operating along two parallel lines. One deals with the classroom learning that follows the outline. The other centers around the machines and is begun by the second week of the course.

By introducing the student to the equipment early in the course interest in learning is maintained and a greater degree of practical experience is possible. Students learn preventative maintenance for the machines as well as the periodic procedures to maintain the equipment.

Hope covers four large machines: the bulldozer, the scrapper, the road grader, and the backhoe. That is a lot of material for a single instructor to cover. No time is wasted. Bad weather gives time to the equipment maintenance or doubling up on classroom study.

To further analyse the heavy equipment curriculum, please refer to pages 141 and 142 . The course has eight chapters that represent a core that the inclusion of the machines are presented. Any number of machines could be developed around this material to present a curriculum on heavy equipment.

Implementation

The implementation of this program is already in effect. The major needs of the schools that have this curriculum is the funding necessary to maintain this equipment, keep it up to date, and provide aids where necessary.

GRADE CHECKER (850.467-010) Sets grade stakes to guide earth moving equipment operators in sloping highways and fill embankments, using measuring instruments and handtools: Reads survey stakes along highway right-of-way to determine grade specification for embankment. Measures horizontally and vertically, in specified ratio, from survey stake to juncture of embankment and initial excavation, using survey rod and eye level. Sets grade stakes, using hatchet, and chalk-marks excavation reference points on stake. Repeats measuring and staking at specified intervals to form horizontal stakeline along embankment. Observes excavating activities to verify conformance to stake references and notifies equipment operators or supervisor of deviations.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly uses hand tools such as sledge hammer, ax, and shovel.
3. Properly uses surveying and other measuring instruments.
4. Observes excavating activities to verify conformance to references.

MOTOR-GRADER OPERATOR (850.663-022) Operates self-propelled grader to spread and level dirt, gravel, and stone, to grade specifications in construction and maintenance of earthwork structures, such as highways, streets, airports, dikes, and temporary roads: Drives grader and moves levers to regulate height and angle of grader blade, lower scarifier that loosens packed soil to permit grading, and to tilt front wheels of grader when making sharp turns. Drives grader in successive passes over working area, observing reference stakes or hand signals of assisting worker, to level surface to specified grade. Feels lever and listens to sound of engine to determine depth of cut. May perform fine or rough grading and be designated motor grader, fine grader, motor grader, rough grade. May operate tractor drawn grader to cut and smooth subgrade on street and highway paving projects and be designated subgrader operator.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly operates self-propelled grader to spread and level in the construction and maintenance of earth work structures by driving grader and moving levers to regulate height and angle of grader blade, lower scarifier that loosens packed soil, or to tilt front wheel when making sharp turns.
3. Observes reference stakes or hand signals of assisting worker, to level surface to specified grade.

STRIPPING-SHOVEL OPERATOR (850.663-026) Operates stripping shovel to remove overburden at strip mine or open pit preparatory to extracting operations: Moves levers and depresses pedals to scoop up blast-loosened dirt and rock from top of coal, ore,or rock seam and to deposit overburden in void left by preceding strip. Piles heavy rock at base and lighter materials on top to build permanent spoil pile. Signals bulldozer operator to scrape scattered rock and dirt into pile within reach of shovel. May repair and replace shovel parts, such as gears, bearings, and bucket teeth, using handtools.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly operates stripping-shovel to remove over-burden at strip mine or open pit preparatory to extracting operations, by moving levers and depressing pedals to scoop up material, and to deposite over-burden in void left by preceding strip.
3. Piles heavy rock at base and lighter materials on top to build permanent spoil pile.
4. Signals bulldozer operator to scrape scattered material into a pile within reach of shovel.

BULLDOZER OPERATOR (850.683-010) Operates tructor equipped with concave blade attached across front to gouge out, level, and distribute earth and to push trees and rocks from land preparatory to constructing roads and buildings or planting crops or in mining, quarrying, and lumbering operations: Fastens attachments to tractor with clevis or wedge-pin hitches. Connects hydraulic hoses, belts, mechanical linkage, or power takeoff shaft to tractor to provide power to raise, lower, or tilt attachment. Moves levers to control tool bars, carriers, and disks. Moves levers and depresses pedals to maneuver tractor and raise, lower, and tilt attachment to clear right-of-way. Feels lever and listens for stalling action of engine to estimate depth of cut. Drives bulldozer in successive passes over terrain to raise or lower terrain to specified grade. May grease, oil, and repair tractor. May be required to work to close tolerances. May operate bulldozer to loosen soil. May be designated according to type of tractor operated as crawler-tractor operator, or attachment added as angledozer operator. May operate bulldozer to scrape surface clay to determine existance and types of clay deposits or to gather clay into piles preparatory to removal to brick and tile manufacturing plant.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly operate tractor with various attachments to gourge out, level, and distribute earth and to push trees and rocks from land preparatory to constructing roads and buildings or planting crops or in mining, quarrying, and lumbering operations.
3. Connects attachments to tractor.
4. Connects hydraulic hoses, belts, mechanical linkage, or power takeoff shaft to tractor to provide power to raise, lower, or tilt attachment.
5. Moves levers to control tool bars, carriers, and disks.

POWER SHOVEL OPERATOR (850.683-030) Operates power-driven machine, equipped with movable shovel, to excavate or move coal, dirt, rock, sand and other materials. Pushes levers and depresses pedals to move machine, to lower and push shovel into material, and to lift, swing, and dump contents to shovel into truck, car, or onto conveyor, hopper, or stockpile. May tend mining machinery, such as pulverizer. May be designated according to type of power unit. May operate power shovel equipped with duck-bill scoop. May operate power shovel which digs by pulling dipper toward machine. May operate power shovel on which excavating bucket runs outward along horizontal boom to dig into materials. May operate power shovel designed to be converted to crane, skimmer scoop, backhoe, or dragline.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly operate power driven machine to excavate material by moving levers and depressing pedals.
3. Connects attachments and power linkage to tractor.

SCRAPER OPERATOR (850.683-038) Operates tractor-drawn or self-propelled scraper to move, haul, and grade earth on construction sites, such as roadbeds, ditch banks, and water reservoirs: Moves switches, levers, and pedals to control loading gate on bucket (scraper), to adjust depth of cut, to raise and close filled bucket for hauling, and to spread or dump earth.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly operate tractor drawn or self propelled scraper to move, haul, and grade earth on construction sites by moving switches, levers, and pedals to control loading gate, depth of cut, to raise and close filled bucket and to spread or dump earth.

UTILITY-TRACTOR OPERATOR (850.683-046) Drives pneumatic-tired tractor and controls grading or digging attachments to move and level materials, such as dirt and gravel, for construction of driveways, parking lots, and streets: Moves levers to engage gears to raise and lower attachment. Adjusts and controls bulldozer attachment to level earth to specified depth. Pulls grader attachment over cutout to trim edges, level surface, and spread rock. Controls back-hoe, trench-digging attachment, or lift-scoop attachment to dig and backfill treaches.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly drives pneumatic tired tractor and controls attachments by moving levers to engage gears.

CONSTRUCTION WORKER (869.687-026) Performs any combination of following tasks, such as erecting, repairing, and wrecking buildings and bridges; installing water works, locks, and dams; grading and maintaining railroad right of ways and laying ties and rails; and widening, deepening, and improving rivers, canals, and harbors, requiring little or no independent judgment; digs,spreads, and levels dirt and gravel, using pick and shovel. Lifts, carries, and holds building materials, tools, and supplies. Cleans tools, equipment, materials, and work areas. Mixes pours, and spreads concrete, asphalt, gravel, and other materials, using handtools. Joins, wraps, and seals sections of pipe. Performs a variety of routine, non-machine tasks, such as removing forms from set concrete, filling expansion joints with asphalt, placing culvert sections in trench, assembling sections of dredge pipeline, removing wallpaper, and laying railroad track. Many of these jobs are not full time, the size of the project and organization of the work determining whether a worker spends all his time on one job or is transferred from task to task as the project progresses to completion. Some workers habitually work in one branch of the industry, whereas others transfer according to the availability of work or on a seasonal basis. May be designated according to specific work performed.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Follow instructions.
3. Perform any combination of the following tasks:

   Erecting, repairing, and wrecking buildings and bridges

   Installing water works, locks, and dams

   Grading and maintaining railroad right of ways and laying ties and rails

   Widening, deepening and improving rivers, canals, and harbors, requiring little or no independent judgment

Digs, spreads, and levels dirt and gravel, using pick and shovel. Lifts, carries, and holds building materials, tools, and supplies. Cleans tools, equipment, materials, and work areas. Mixes pours, and spreads concrete, asphalt, gravel, and other materials, using handtools. Joins, wraps, and seals sections of pipe. Performs a variety of routine, nonmachine tasks, such as removing forms from set concrete, filling expansion joints with asphalt, placing culvert sections in trench, assembling sections of dredge pipeline, removing wallpaper, and laying railroad track.

DUMP TRUCK DRIVER (902.683-010) Drives truck equipped with dump body to transport and dump loose materials, such as sand, gravel, crushed rock, coal, or bituminous paving materials; Pulls levers or turns crank to open bed and dump contents. Moves hand and foot controls to jerk truck forward and backward to loosen and dump material adhering to body. May load truck by hand or by operating mechanical loader. May be designated according to type of material hauled or type of equipment driven.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly drive truck equipped with dump body to transport loose materials.
3. Properly pulls levers or turns cranks to open bed and dump contents.
4. Moves hand and foot controls to jerk truck forward and backward to loosen and dump material adhering to body.

TRACTOR TRAILER TRUCK DRIVER (904.383-010) Drives gasoline or diesel-powered tractor-trailer combination, usually long distances, to transport and deliver products, livestock, or materials in liquid, loose or packaged form: Drives truck to destination, applying knowledge of commercial driving regulations and skill in maneuvering vehicle in difficult situations, such as narrow passageways. Inspects truck for defects before and after trips and submits report indicating truck condition. Maintains driver log according to I.C.C. regulations. May assist workers in loading and unloading truck. May transport new automobiles or trucks from manufacturers or rail terminals to dealers. May drive tractor with two trailers hitched in tandem. May drive tractor trailer combination to deliver poles for utility and construction companies. May work as member of two man team driving tractor with sleeper bunk behind cab. May drive tractor trailer combination to deliver or spray water.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly operates gasoline or diesel powered tractor trailer combination to transport and deliver material.
3. By apply knowledge of commercial driving regulations and skill in maneuvering vehicle in difficult situations, drives truck to destination.
4. Inspects truck for defects before and after trips and submits a report indicating truck condition.
5. Maintains driver log according to I.C.C. regulations.

HEAVY TRUCK DRIVER (905.663-014) Drives truck with capacity of more than 3 tons, performing duties similar to those of truck driver, light. May position blocks and tie rope around items to secure cargo during transit. When driving truck equipped for specific purposes, such as fighting fires, digging holes, and installing and repairing utility company lines, may be designated accordingly. May be designated according to type of truck driven as truck driver. May be designated according to kind of cargo transported.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly operates truck with capacity above three (3) tons.
3. May position blocks and tie rope around items to secure cargo during transit.

WATER TRUCK DRIVER (905.683-010) Drives tank truck to transport water for construction projects or to provide water for use in drilling shallow bore-holes on petroleum-prospecting sites. May insert pipe in refilled trenches and other excavations, and operate auxiliary pump on truck to pump water into fill to settle and compact dirt. May drive truck equipped with sprinkling attachment to settle dust on roadways and streets and to saturate flexible base for compaction. May drive truck equipped with trailer.

SPECIFIC SKILLS REQUIRED

1. Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.
2. Properly drives truck to transport water.
3. May operate auxiliary pump on truck to pump water.
4. May drive truck equipped with sprinkling attachment.

SUGGESTED ASSIGNMENTS IN

"MOVING THE EARTH" TEXTBOOK

1st week -	Basic Information, Chapter 12, Page 1-35	Written Test
2nd week -	Basic Information, Chapter 12, Page 35-106	"
3rd week -	Tractors and Bulldozers, Chapter 15, Page 1-30 Safety film and operator guide film (tract type tractor)	"
4th week -	Tractors and Bulldozers, Chapter 15, Page 30-50	"
5th week -	Scrapers, Chapter 17, Page 1-26 Safety film and operator guide film (rubber tired scraper)	"
6th week -	Scrapers, Chapter 17, Page 26-48	"
7th week -	Surveys and Measurements, Chapter 2, Page 1-37	"
8th week -	Grading and Compacting Machinery, Chapter 19, Page 1-30, Safety film and operator guide film (road grader)	"
9th week -	Grading and Compacting Machinery, Chapter 19, Page 30-58	"
10th week -	Soil and Mud, Chapter 3, Page 1-48	"
11th week -	Land Clearing, Chapter 1, Page 1-33 Safety film	
12th week -	Miscellaneous Equipment, Chapter 21, Page 1-80	"
13th week -	Roads, Chapter 8, Page 1-29	"
14th week -	Roads, Chapter 8, Page 29-50 Film - "One Turn of the Earth" (J' A' Riggs)	"
15th week -	Pit Operation, Chapter 10, Page 1-27	"
16th week -	Pit Operation, Chapter 10, Page 27-56	"
17th week -	Ponds, Chapter 6, Page 1-44	"
18th week -	Ditching and Dewatering, Chapter 5	"
19th week -	Ditching and Dewatering, Chapter 5	"
20th week -	Revolving Shovels, Chapter 13, Page 1-29	"
21th week -	Revolving Shovels, Chapter 13, Page 29-61	"
22nd week -	Revolving Shovels, Chapter 13, Page 61-108	"
23rd week -	Final Test	

HEAVY EQUIPMENT CORE MATERIAL

TITLE	CHAPTER	TIME
Basic Information *	12	2 Weeks
Surveys & Measurements *	2	1 Week
Soil & Mud	3	1 Week
Land Clearing *	1	1 Week
Roads	8	2 Weeks
Pit Operation	10	2 Weeks
Ponds	6	1 Week
Ditching & Dewatering *	5	2 Weeks

*Indicates inclusion of machinery.

MACHINES

TITLE	CHAPTER	TIME
Tractors and Bulldozers	15	2 Weeks
Scrapers	17	2 Weeks
Grading and Compacting Machinery	19	2 Weeks
Miscellaneous Equipment	21	1 Week
Revolving Shovels	13	3 Weeks
Conveyor Machinery	14	
Tractor Loaders	16	
Trucks	18	
Compressors and Drills	20	

Other Areas of Study

Costs	11
Cellars	4
Landscaping & Agricultural Grading	7
Blasting & Tunneling	9

HEAVY EQUIPMENT

BIBLIOGRAPHY

Building Trades - Heavy Equipment Guide. Nebraska Department of Education.

Crickmer, Douglas F. David A. Zegeer, Elements of Practical Coal Mining. Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. New York, New York, 1981.

Heavy Equipment Operation amd Maintenance. State Board of Education, Illinois Office of Education, Department of Adult-Vocational and Technical Education, Research and Development Section, 1976.

Nichols, Hebert L. Jr. Moving the Earth. The Workbook of Excavation, North Castle Books, Third Edition, 1976.

Stack, Barbara, Handbook of Mining and Tunnelling Machinery. John Wiley & Sons, 1982.

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Arkansas Democrat
THURSDAY, NOVEMBER 18, 1982 B

144.

AP&L says it won't need lignite plant until 1990s

BY JONATHON RUNNELLS
Democrat Staff Writer

HAMPTON – Dreams of using Calhoun County lignite coal in a proposed Arkansas Power & Light Co. electric generating plant have been put on the back burner again.

The electric company on Wednesday announced a delay in the completion of a lignite-fueled electric generating plant until the mid-1990s.

Jack King, senior vice president for energy development at AP&L, attributed the delay to a slowdown in growth for demand of electricity.

"It's still scheduled to be our next power plant," he said. "It just won't be needed as early as we thought."

Construction of the facility originally was scheduled for completion by 1988. The time frame later was pushed back to between 1990 and 1992.

When the facility was planned, King said, the state was undergoing an 8 percent to 10 percent increase in demand per year. The annual growth rate has since slipped to about 3 percent per year.

Several factors contributed to the slowdown in the demand growth rate, he said. The economy has forced many manufacturing plants to shut down, causing a decline in industrial demand for power. The price of electricity also forced more strict conservation measures, which also cut down on demand.

King said AP&L already had invested more than $1 million in research for the $1.5 billion plant.

A new estimate based on mid-1990s costs has not been prepared, but the cost increase probably will be "significant," he said.

He added that the plant construction could be moved up depending on the overall economy. If the growth rate increases, he said, AP&L will take the necessary steps to meet the demand.

He pointed out that power plants are usually planned 10 years in advance.

"That's part of the problem," King said. "You have to project 10 years ahead of time. With the economy unstable as it is, that's a very difficult thing to do."

Calhoun County Judge Bill Wylie said the delay was a disappointment but not entirely unexpected.

"We were kind of looking for it, due to conservation and all," Wylie said. "But if they don't need the electricity, we can understand it. We don't like it, but we understand it."

The county, the smallest in Arkansas in terms of population, stands a chance of experiencing growth when the power facility finally comes on line.

The town of Mount Pleasant, experienced a 50 percent rate when a similar facility was constructed in the 1970s.

The population of Calhoun County has grown only 1.5 percent since 1960. Arkansas' population increased almost 30 percent over the same period.

Though the county is sparsely populated, most people are employed. The state Employment Security Division listed the jobless rate in Calhoun County at 8 percent in September.

Wylie said the facility was expected to employ up to 1,200 people during construction and 400 after. The coal mine operation would have provided another 1,000 jobs, he said, adding that Shell Oil Co., which will operate the mine, may find other markets to sell the brownish coal.

Mike Dennis, an aide to U.S. Rep. Beryl Anthony, D-Ark., said the congressman would be disappointed in the delay but not surprised.

"Economic conditions dictate prudent measures," Dennis said.

Anthony, a strong supporter of lignite development, was not available for comment.

Lignite is a soft coal that contains more carbon than peat. The Sparta mine in Calhoun County will provide 8 million tons of lignite, the equivalant of 16 million barrels of crude oil, a year for the power plant.

Angus Benson, president of the Hampton Chamber of Commerce, said the delay in construction was understandable.

He said he had spoken to Shell Oil officials, who had assured him they were committed to developing the lignite mine. He said more markets for the coal could be found but added, that channelization of the Ouachita River was necessary to transport the material.

Wylie said some residents had bought land with the hope of cashing in when the plant was constructed but added that speculation about the plant had been minimal.

BEST COPY AVAILABLE

BIBLIOGRAPHY

Adams, James E. Electrical Principles and Practices. McGraw-Hill, Inc. Second Edition, 1963.

Alerich, Walter N. Electrical Construction Wiring. American Technical Publishers, Inc., 1971.

Allen, Dell K. Metallurgy Theory and Practice. American Technical Publishers, Inc., 1981.

Allen, Dell K. Mortensen, Kay S. Metallurgy and Materials Science Laboratory Manual. American Technical Society, 1973.

Arkansas Department of Labor. Electrical Hazards Control Manual. 1977.

Arthur, Harlan R. Albert M. Wagener. Machine Shop Theory & Practice. Second Edition. D.Van Nostrand Company, Inc., 1950.

Ashkouti, Joesph, A. Aircraft Mechanic's Pocket Manual. Pitman Publishing Corp. Second Edition, 1942.

Begeman, Myron L. Manufacturing Processes. John Wiley and Sons, Inc. Second Edition, 1947.

Benton, Helen, William Benton. Encyclopedia Britannica. Encyclopedia Britannica, Inc., 1974.

Birt, H.B. The Battery Side of Voltage Regulation. Delco-Remy Division, 1952.

Building Trades - Heavy Equipment Guide. Nebraska Department of Education.

Chaplin, Jack W. Metal Manufacturing Technology. McKnight Publishing Company, 1976.

Claussen, G.E. O.H. Henry. Welding Metallurgy. The American Welding Society, 1940.

Compton's Encyclopedia. F.E. Compton Company, Division of Encyclopedia, Inc., 1975.

Crickmer, Douglas F. David A. Zegeer, Elements of Practical Coal Mining. Society of Mining Engineers of The American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. New York, New York, 1981.

Culpepper, Fred W. Jr. Rex Miller. Energy: Electricity/Electronics. South-Western Publishing Company, 1982.

D-C Equipment & Controls. Technical Publishing Company, 1974.

Dees, Sherwood, Director, Electricity Occupations Curriculum Guide. Illinois Office of Education, Division of Vocational and Technical Education, July, 1975.

Driscoll, Edward F. Industrial Electronics. Devices, Circuits, and Applications. American Technical Publishers, Inc., 1976.

Edwards, Kenneth R. Kenneth L. Gebert. Transformers. Principles and Applications. American Technical Publishers, Inc., Second Edition, 1981.

Feirer, John L. J.W. Giachino. Basic Bench-Metal Practice and Precision Measuring. Charles A. Bennet Company, Inc. 1943.

Feirer, John L. General Metals. McGraw-Hill Book Company, Fourth Edition, 1974.

Feirer, John L. Earl E. Tatro. Machine Tool Metalworking. McGraw-Hill Book Company, Inc. 1961.

Ford, Walter B. William B. Steinberg. Electricity and Electronics - Basic. American Technical Publishers, Inc., 1972.

Gebert, Kenneth L. National Electrical Code Blueprint Reading. American Technical Publishers, Inc., Eight Edition, 1980.

German, Carl, Jr. A Guide For Planning Facilities for Occupational Preparation Programs in Metallurgy Technology. The Center For Vocational and Technical Education, 1969.

Giacho, J.W. W. Weeks, G.S. Johnson. Welding Technology. American Technical Society, Second Edition, 1973.

Heavy Equipment Operation and Maintenance. State Board of Education, Illinois Office of Education, Department of Adult-Vocational and Technical Education, Research and Development Section, 1976.

Hubert, Charles I. Preventive Maintenance of Electrical Equipment. McGraw-Hill Book Company, Second Edition, 1969.

Jefferson, T.B. Gorham Woods. Metals and How to Weld Them. The James F. Lincoln Arch Welding Foundation, Second Edition, 1962.

Johnson, Carl,G. William R. Weeks. Metallurgy. American Technical Publishers, Inc. Fifth Edition, 1977.

Jones F.D. Erik Oberg. Machinery's Handbook. The Industrial Press, Eleventh Edition, 1942.

Kubala, Thomas S. Electricity I, Devices, Circuits, Materials. Delmar Publishers, Inc. Third Edition, 1981.

Lubrication-Proper Selection and Use of Lubricants Within the Plant. Technical Publishing Company, 1974.

MyIntyre, R. L. Electric Motor Control Fundamentals. McGraw-Hill, Inc. 1974.

Metallurgical Technology. U.S. Department of Health, Education, and Welfare, 1968.

Metallurgy and Metals Properties. Technical Education Research Center, Inc., 1977.

Miller, Rex. Industrial Electricity. Charles A. Bennet Company, Inc. 1978.

Mullin, Ray, C. Electrical Wiring Residential. Delmar Publishers, 1975.

National Electrical Code 1981. National Fire Protection Association, 1980.

Neely, John. Practical Metallurgy and Materials of Industry. John Wiley & Sons, Inc., 1979.

Neely, John, Instructor's Manual - Practical Metallurgy and Materials of Industry.

Nichols, Hebert L. Jr. Moving the Earth. The Workbook of Excavation, North Castle Books, Third Edition, 1976.

Principles of Lubrication. Exxon Corporation, 1973.

Procedure Handbook of Arc Welding Design and Practice. The Lincoln Electric Company, Seventh Edition, 1942.

Ravielli, Anthony. An Adventure in Geometry. The Viking Press, New York, 1957.

Regulation and the Charging Circuit. Delco-Remy.

Richardson, M.T. Practical Blacksmithing. Weathervane Books, New York, 1978.

Rockis, Gary. Residential Wiring. American Technical Publishers, Inc., 1978.

Saunier, Claudius. The Watchmaker's Hand Book. Hazlitt and Walker, 1903.

Seippel, Robert C. Fundamentals of Electricity, Basics of Electricity, Electronics, Controls, and Computers. American Technical Publishers, Inc. 1974.

Shrader, Robert L. Electrical Fundamentals for Technicians. McGraw-Hill, Inc. Second Edition, 1977.

Smith, Robert L. Electrical Wiring Industrial. Delmar Publishers, 1977.

Stack, Barbara, Handbook of Mining and Tunnelling Machinery. John Wiley & Sons, 1982.

The Encyclopedia Americana. Americana Corp., 1971.

The New Book of Knowledge. Grolier, Inc., 1976.

Untracht, Oppi. Metal Techniques for Craftsmen. Doubleday & Company, Inc., 1968.

Wigginton, Eliot. Foxfire 5. Ironmaking, Blacksmithing, Flintlock rifles, Bear Hunting, and other affairs of plain living. Anchor Books, Anchor Press Doubleday, 1979.

Wildi, Theodore, Michael J. De Vito. Investigations in Electric Power Technology. Buck Engineering Company, Inc. 1971.

Zim, Herbert S. Ph. D. Our Wonderful World. Grolier, Inc., 1966.

APPENDIX

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ABSTRACT

Mining & Power Production Technology Curriculum Research for Southeast Arkansas Area Impacted by New Lignite Industry

The Warren School District through the Warren Area Vocational-Technical Center will catagorize occupations within the mining and power production industry according to needs of secondary and post secondary vocational-technical training. Entry level skills for each occupation will be determined in cooperation with the industry and related skills will be grouped into training programs. Curriculum outlines will be developed for each training program along with minimum equipment lists, text and AV material suggestions, minimum tool lists and suggested supplies and materials.

There will be three briefing schedules for teacher inservice programs and updating the industrial cooperators on the progress and direction of the project.

Research into a time frame for implementation of the training programs will be conducted in cooperation with the industry, secondary and post secondary vocational-technical schools of the impacted area and with the Arkansas Employment Security Division.

The work shall be accomplished by a staff consisting of one Curriculum Specialist and a Clerk-Typist working for the project director beginning September 1, 1980 and ending June 30, 1981 at which time continuance will be negotiated.

The Budget will include salaries of the Curriculum Specialist and Clerk-Typist, travel for the staff and project director, materials and supplies including sample texts, etc. The school district will furnish a part time project director, office space, office equipment, and existing technical library.

PROJECT NUMBER:

PROJECT TITLE: Mining and Power Production Technology Curriculum Research for Southeast Arkansas Area Impacted by New Lignite Industry

PROJECT DIRECTOR AND ORGANIZATION: Fred Robinson, Director
Warren Area Vo-Tech Center
Warren, AR 71671
Phone (501) 226-6920

DURATION OF PROJECT: September 1, 1980 through June 30, 1981

PURPOSE AND OBJECTIVES:

PURPOSE: The intent of this work is to provide the vocational education institutions of Southeast Arkansas with the training needs of several occupations within the lignite mining and power production industry scheduled to begin in the near future. The objectives will be parallel for secondary and post secondary training.

OBJECTIVES:

1. Determine occupations within the industry that may be entered from training provided at the secondary vo-tech centers.

2. Determine occupations within the industry that may be entered from training provided at the post secondary vo-tech centers.

3. Determine entry level skills required for those occupations entered from secondary level.

4. Determine entry level skills required for those occupations entered from post secondary level.

5. Group secondary skills into instructional programs.

6. Write course outlines with references, texts, AV material, etc. for each secondary instructional program. Included would be a list of equipment, tools, and materials needed for the operation of the program.

7. Group post secondary skills into classes.

8. Write course outlines with references, texts, AV materials, etc. for each post secondary class. Included would be a list of equipment, tools, and materials needed for the operation of the program.

9. Conduct three briefings (phase: 1, 2, 3) at each vo-tech center involved and with cooperating industry representatives to keep communication open among all involved in the research.

10. Prepare a time table for implementation of proposed programs with justification.

NEED:

The overall purpose of the project is to extend the process begun in the Spring of 1980. A research project funded by the State Department of Education, Vocational Division developed a comparative analysis of industrial growth and potential growth comparing the Warren, Arkansas area and Mt. Pleasant, Texas (nearest lignite facility). This coupled with manpower requirements supplied by Arkansas Power and Light Company and Shell Oil Corporation for the lignite mine and power plant prompted a study of training capability in three high school area Vo-Tech centers and three post secondary Vo-Tech schools. Conclusions drawn from that research prompted a Phase II project (this proposal) to enable the Vo-Tech schools to plan for the future. Phase II will designate training programs reflecting industrial requirements related to the lignite power production industry for secondary schools and post secondary schools. A copy of the final report of Phase I is attached.

RESULTS OR BENEFITS EXPECTED:

This project will provide a re-evaluation of training programs allowing for new skills training particular to the needs of industry. There will be curriculum changes within existing programs and new programs developed. The determination of entry level skills of the various occupations will help to build a continuing education program from secondary to post secondary to industry. Curriculum outlines will be developed to show the scope of training programs. These outlines developed in cooperation with educators and industrialists will ensure that the training programs meet the needs of industry. This may help gain industrial support in developing facilities and equiping them which will be the emphasis of Phase III.

PROCEDURE:

Overall Plan of Action

The Curriculum Specialist and Clerk-Typist will be housed in office space at the Warren Area Vo-Tech Center where they will work under the supervision of the Area Center Director acting as the Project Manager.

The project staff will contact, call and visit with vocational administrators within the project area and industrial officials of major industries and the lignite industry in particular. These communications will provide data for meeting the objectives. The project area will be comprised of the service areas of Vo-Tech schools at McGhee, Crossett, Monticello, Warren, Eldorado, and Camden. Office work will be necessary to maintain communications and develop the curriculum outlines. A major emphasis will be placed in securing cooperation with industry to develop the occupational catagories and entry level skills required for those occupations.

The course outlines will be topic outlines or listings of suggested units of study. These will be reviewed by Vo-Tech administrators and industry representatives prior to final copies being run.

The briefings for vocational personnel and industrial representatives will be made at three times during the project. These will be informal presentations and question and answer sessions for input from vocational personnel and industrial representatives.

The time table for the new program implementation will depend on whether secondary or post secondary training is required and the start up date for the lignite industry.

MANAGEMENT PLAN:

The budget will be handled according to present accepted methods for vocational funded programs. The recipient would be the Warren School District.

A time table for meeting the objectives would be as follows:

September 1, 1980	Begin
December 1, 1980	Objectives 1, 2, 3, 4, and phase 1 of 9
February 1, 1981	Objectives 5, 7, and phase 2 of 9
April 1, 1981	Objectives 6, 8 (outlines only) and phase 3 of 9
June 30, 1981	All objectives and final report

Interim reporting will be taken care of as requested.

EVALUATION:

In order to hold the costs to a minimum the evaluation of this project will be conducted by the research personnel of the State Department of Education, Vocational Division. The evaluation would be in three parts corresponding to each briefing scheduled in objective 9. Interim reports will be prepared as deemed necessary.

PERSONNEL AND FACILITIES:

The Director of the Warren Area Vo-Tech Center will administer the program as the Project Director under the supervision of Mr. J.M. Hughes, Superintendent of Schools, Warren School District. Fred Robinson, Director will spend 10-15% of his time in work with the project staff. The project staff will be comprised of a Curriculum Specialist and a Clerk-Typist. The Curriculum Specialist should have a Masters Degree in Vocational Education or equivalent experience. The Clerk-Typist shall be competent in typing and other office skills. Both staff will be housed in an office area at the Warren Area Vo-Tech Center, provided with office furniture and suitable equipment. A large percent of the Curriculum Specialist's time will be spent in travel during certain portions of the project. This would require this staff member to own suitable transportation for this travel subject to monthly reinbursement at the state approved rates. For aid in developing the curriculum outlines the center will provide use of the existing technical library.

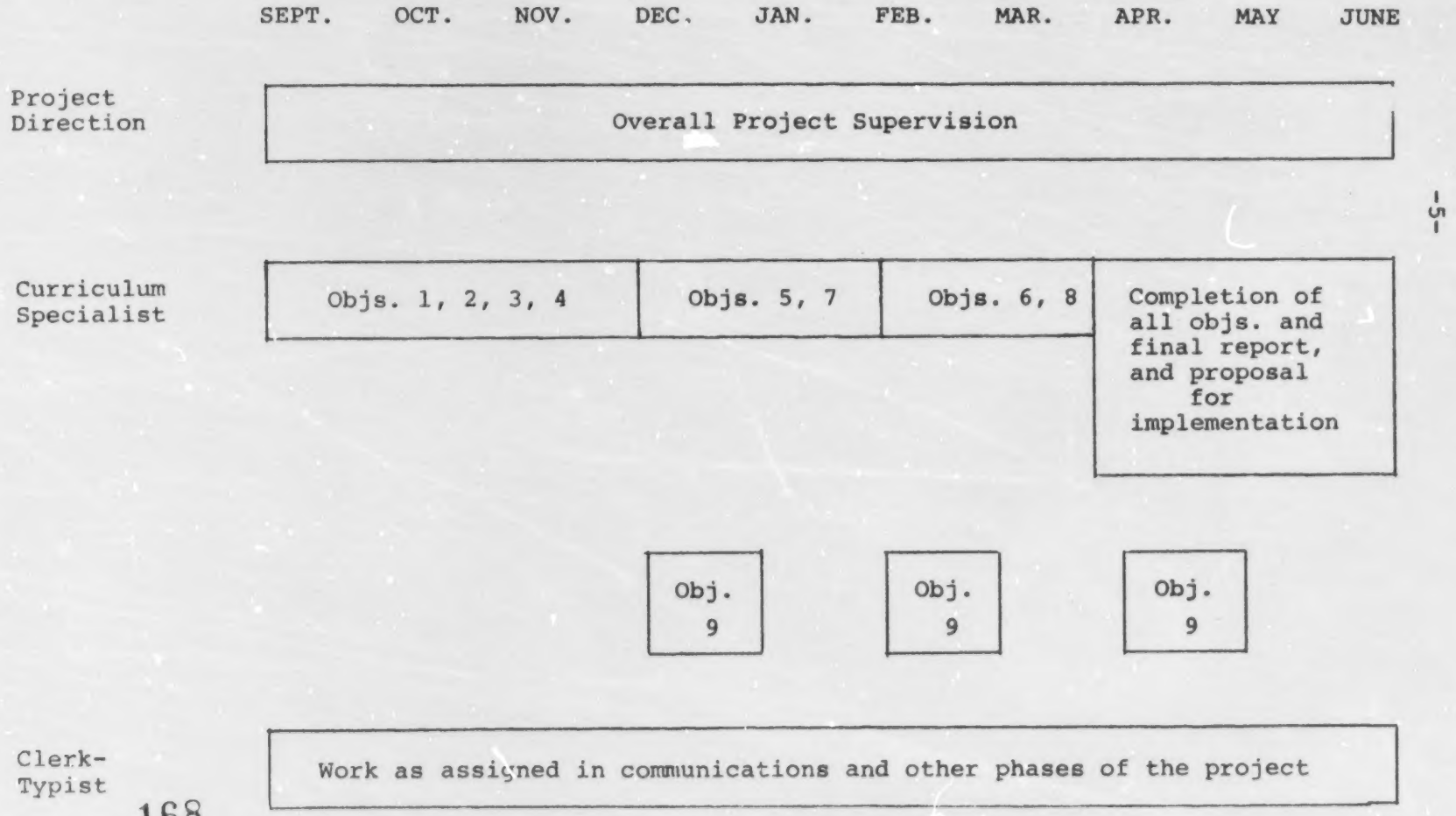
DISSEMINATION:

Communications among all interested parties will be assured by the briefing schedule mentioned in the procedures section and objective 9. There will be three briefing schedules offering discussion with and input from the vocational-technical centers and industrial representatives. Each briefing schedule will be recorded in writing and made a part of the final report. The final report and interim reports will be disseminated as negotiated with the State Department of Education.

ASSURANCES:

In carrying out this project, The Warren Area Vocational Technical Center will comply with the regulations, policies, guidelines, and requirements of the Federal legislation dealing with discrimination on the basis of race, color, religion, sex, national origin, age, or handicap.

ANTICIPATED CHRONOLOGICAL PROGRESS



BUDGET

TITLE: Mining and Power Production Technology Curriculum Research for Southeast Arkansas Area Impacted by New Lignite Industry

PROJECT DURATION: September 1, 1980 through June 30, 1981

APPLICANT: Warren Area Vo-Tech Center
Warren School District
800 N. Walnut
Warren, Arkansas 71671

Budget Categories		Funds Requested	Local Contributions
A. Personnel:			
(1) Project Director, Fred Robinson 10% time for 10 months		NA	$1,550.00
(2) Curriculum Specialist full time for 10 months		$13,000.00	
(3) Clerk-Typist, 3.30/hr. full time for 10 months (41 weeks)		5,075.00	
B. Employee Benefits:			
Social Security	1,108.00		
Teacher Retirement	2,228.65		
Unemployment	343.33	3,679.98	
C. Travel:		1,000.00	
D. Supplies and Materials:		500.00	
E. Communications:		NA	450.00
		$23,255.00	$2,000.00

/

Project Abstract

Project Number:	P80-01
Project Title:	Vocational Education Inservice Training For Areas Impacted by New Lignite Industry
Project Director And Organization:	Fred Robinson, Director Warren Area Vo-Tech Center Warren, Arkansas 71671
Duration of Project:	March 1 ,1980-June 30, 1980

Objectives or Purposes:

The overall purpose of this project is to determine the role of the Warren Area Vo-Tech Center in meeting the emerging educational and training needs of new industry coming to the area.

Data will be compiled and analyzed regarding the skilled labor needs of the new developing lignite and power generating industry coming to Southeast Arkansas.

The study will include (1) a comparative analysis between the Warren area and that of Mt. Pleasant, Texas, regarding changes resulting from the lignite mining and power production industrial impact on that community, (2) a study of any vocational program changes in Mt. Pleasant to meet the needs of industrial growth there, and (3) a study of existing secondary and post secondary vocational programs in Southern Arkansas as to present capability to meet the needs of the new mining and power production industries.

Expected Outcome:

It is anticipated that the processes outlined above will result in the following:

1. Skilled labor needs of the new industries and that of related industrial growth in the Warren area will be identified.
2. Capabilities of both the secondary and post secondary vocational schools in South Arkansas will be determined.
3. A plan of action will be made for the Warren Vo-Tech Center, outlining necessary adjustments in order to meet the anticipated needs in vocational training.

Need, Rationale and Objectives

Since it became known in 1979 that the Arkansas Power and Light Company was going to build a large electric generating plant near Hampton and there would be a lignite mining operation established there to support the power plant, the Warren public school officials have been studying the situation and making preparations to meet the impact on the schools.

Because of the demand for more labor, it was assumed there will be a large movement of workers with their families, not only to the Warren area, but, to other surrounding communities like Hampton, Banks, Hermitage, Fordyce, Rison, Woodlawn, New Edinburgh and Kingsland, which all send students to the Warren Area Vo-Tech Center for their vocational technical training.

It was also assumed that the growth of these new industries would create a demand for many more technically trained workers from the communities in this impacted area. The responsibility for this training is to be accepted by the Warren Area Vo-Tech Center. The Warren school board and those of all the cooperating schools endorsed the idea of having the Warren Vo-Tech Center prepare to exercise that responsibility.

The purpose of this project, in determining the exact role Warren Vo-Tech Center can play, is to do these things:

1. Determine the capability of each secondary and post secondary vo-tech school in Southeast Arkansas for providing the technical training needed, by a survey of the schools.

2. Determine the available labor supply in Southeast Arkansas, with the help of Employment Security Division.

3. Determine the local labor demand, by a survey of local industries.

4. Identify the labor needs of both the lignite mining and power production industries, with their help.

5. Study the changes and pattern of growth that have taken place in Mt. Pleasant, Texas, as to population, local industrial growth, curriculum at the Area Vo-Tech school, school enrollment, etc. since the emergence of their lignite mining and power production industries in 1973.

6. Determine what adjustments must be made in both the curriculum and personnel at Warren Area Vo-Tech Center in order for it to meet the anticipated training needs.

This process is intended to establish a pattern for other Arkansas vocational schools that experience industrial development of the same nature in their communities.

Secondary and Post Secondary Schools Capability of Meeting Needs Mining and Power Production Industry

Secondary Schools

In Southern Arkansas there are three area Vo-Tech schools at the secondary level. They are located at Warren, Monticello and Camden. As shown in Table 1, they graduated a total of 272 students in 1979, the majority of which were in Health Occupations, Auto Mechanics, and Building Trades. The trades least represented among those graduates were Machine Shop, Metal Trades, Heating and Refrigeration (Electricity being taught in this course). Mechanics and electricians are expected to be in great demand at the mining and power production project near Hampton.

The Warren Area Vo-Tech Center, serving 8 other schools, had in attendance on March 11, 1980, a total of 254 students. See Table 2. Warren and all cooperating schools had a total high school enrollment of 2221. 11.4% of total enrollment is receiving vo-tech training.

However, Table 3 reveals for each cooperating school the % of total high school enrollment receiving training in some vocational program, ranging from 36% to 100%. It is noted that 67% of the Warren student body is getting some vocational training, while, at New Edinburgh, it is 100%.

As is seen in Table 4, Warren is over-enrolled in the Industrial Mechanics program, but is under-enrolled in each of the other programs. The greatest under-enrollment is in the Business Skills, Forestry, Auto Mechanics, and Textile programs.

Post Secondary Schools

Table 5 shows the training programs being offered in the Post Secondary Schools at Crossett, McGhee, and El Dorado, which graduated a total of 228 trainees in 1979. Those graduates represented greatest interest in the programs of Secretarial, Clerical, and Practical Nursing. Next major interest was in welding, Auto Mechanics, and Machine Shop programs. Trades least represented were Appliance Service, Electronics and Electricity, Forestry, Diesel Mechanics, Industrial Equipment, and Drafting.

Summary

It is apparent that, for the vo-tech schools to meet the labor demands of the lignite mining and power production industry coming to Southeast Arkansas, more emphasis should be given to training in electrical and mechanical trades.

And, to meet the needs of growing local industries, more emphasis should be given to training in Auto Mechanics, Construction Trades, Appliance Service, Electricity, and Welding. This is according to the pattern that developed in local industrial growth at Mt. Pleasant, Texas, after the lignite mining and power production industries became established in that community.

Southeast Arkansas Area Vo-Tech Schools

Enrollment By Courses At Semester, 1979-1980

Also 1979 Graduates

Table No. 1

	Monticello	Camden	Warren	Graduates 1979
Industrial Equipment & Welding	33	32	43	25
Business Skills			23	10
Health Occupations	16	45	36	50
Heating and Refrigeration			32	9
Forestry			29	12
Auto Mechanics & Diesel	42	43	29	58
Textiles	38		29	15
Building Trades	25	47	33	54
Drafting	10	22		18
Metal Trades	16			6
Machine Shop		25		6
Cosmetology		15		9
Printing		20		0
			TOTAL	272

Sources: Local School Administrators

Schools Being Served By Warren Area Vo-Tech Center

Enrollment By Grades As of January, 1980

Also, Attendance At Warren Center As of March 10, 1980

Table No. 2

Schools	9th	10th	11th	12th	Total	Attending Warren Vo-Tech Center
Banks High School	11	6	13	6	36	13
Fordyce High School	114	102	99	112	427	34
Hampton High School	75	71	75	80	301	34
Hermitage High School	57	66	84	74	281	17
Kingsland High School	23	18	16	15	72	1
New Edinburg High School	34	27	21	22	104	7
Nison High School	61	65	62	48	236	0
Warren High School	139	168	153	151	611	113
Woodlawn High School	34	45	36	38	153	35
Grand Totals					2,221	254

Sources: Local School Administrators

Total Vocational Program - Cooperating Schools

Table No. 3

Schools	Vo-Tech	Vo-Agr.	G.E.C.	Home Ec.	Occup. Home Ec.	Total In Vocational	% Total Vocational	High School Enrollment
Banks	13	0	0	0	0	0	36%	36
Fordyce	34	0	39	84	0	157	37%	427
Hampton	34	109	22	70	0	226	75%	301
Hermitage	17	97	0	109	0	223	80%	281
Kingsland	1	26	0	30	0	57	80%	72
New Edinburgh	7	43	0	54	0	104	100%	104
Rison	0	79	0	89	0	168	71%	236
Warren	113	119	44	116	19	411	67%	611
Woodlawn	35	0	0	56	0	91	60%	153

Source: Cooperating Schools

Current Vo-Tech Programs, Enrollments, and Capacity At

Warren Area Vo-Tech Center

Date: April, 1980

Table No. 4

Vo-Tech Programs And Courses	Enrollment		Over or Under Enrollment	Number Students By Grade Level		
	Capacity	Current		10	11	12
Industrial Equipment Mechanics	40	43	+3		30	13
Business Skills	40	23	-17		8	15
Health Occupations	40	36	-4		14	24
Heating & Refrigeration	40	32	-8		23	9
Forestry	40	30	-10		8	22
Auto/Diesel	40	29	-11		17	12
Textiles	40	29	-11	1	19	9
Building Trades	40	32	-8	1	16	15

Source: Warren Vo-Tech Center

Area Courses Available in Southeast Arkansas Post Secondary Vo-Tech Schools - Alsc 1979 Graduates

Table No. 5

Courses	Crossett	McGhee	Eldorado	Graduates 1979
Air Conditioning	x		x	10
Appliance Service			x	0
Carpentry		x	x	13
Construction Trades		x	x	
Electronics & Electricity	x		x	4
Forestry	x		x	1
Machine Shop	x		x	18
Auto Mechanics		x	x	24
Diesel		x		0
Industrial Equipment	x	x		4
Practical Nursing		x	x	42
Bookkeeping & Accounting	x	x	x	10
Clerical Skills		x	x	31
Secretarial	x	x	x	41
Welding	x	x	x	22
Drafting			x	8
			TOTAL	228

Sources: Local School Administrators

Local labor demand

A recent survey of local industries (see Table 6) reveals the number of persons currently employed in the Warren area by occupational categories.

It is noted that the categories in greatest demand are mechanics, millwrights, electricians, welders, and sawfilers, ranked as to priority in this order. However, the annual turnover is reported to range from 10% to 30%, replacement rates being greatest in the smaller operations.

The Georgia Pacific Plywood Mill at Fordyce, which is currently closed down, did not report employees as did the other industries, but suggested more training at the Warren Vo-Tech Center in electrical trades and in general maintenance.

Both Potlatch, a lumbering business and largest of the local industries, and Georgia Pacific's plywood mill at Fordyce reportedly train about 90% of their employees. Due to current economic conditions, neither Potlatch or Georgia Pacific would estimate future labor needs.

Each of the smaller industries indicated plans for expansion in future years. particularly the two manufacturers of ladies sportswear. This indicates an especially good future for textile trainees at Warren Vo-Tech.

An analysis of this survey seems to indicate a local need for expansion in training for both electrical workers and general maintenance. Then, possibly adding a program for the training of wood technologists who would find employment at Branwood Corporation, a local furniture factory.

Labor Demand

by

Local Industry

Table No. 6

Local Industry	- Presently Employed - Welders	Mechanic	Millwright	Electrician	Machinist	Electronic Tech.	Sawyer	Sawfiler	Engineer Boiler Room	Furniture Sawing Operator	Sewing Machine Operator
Potlatch Corp. Lumbering Warren	8	12	25	14	7		11	15	7		
Sykes Flooring, Inc. Warren		18	1	3	1		1	4			
Phelps Dodge, Inc. Communications Fordyce	12	12		6	2	2					
Branwood Corp. Furniture Mfg. Warren										115	
Jack Winter, Co. Sportswear Mfg. Warren											210
Ladonna Inc. Sportswear Mfg. Warren											120
183 TOTALS	20	42	26	23	10	2	12	19	7	115	330

Sources: Local Industry Survey

Local Labor Supply

Provided by Arkansas Business and Economic Review, Table 8 shows a preliminary estimate of the civilian labor force in the 10 Southeast Arkansas Counties, as of June 1979. Although the unemployment rate was only about 6% at that time, the total unemployed work force was 4,650.

However, the unemployed work force within the counties nearest to the proposed lignite development area total 868. These nearest counties are Bradley, Calhoun, Cleveland and Dallas.

Tables 7 through 18, with information from the Employment Security Division, reveals the number of job applicants by occupational category (who claim some experience) in nine of the Southeast Arkansas counties. See Table 18. Applicants in the categories of carpentry, structural work, and machine trades (the ones most likely to find employment in construction at the lignite and power production projects) number about 400 each. This is significant in view of the fact that many of the applicants are within commuting distance of the work area.

These tabulations reflect, also, what seems to be minimal current employment opportunities for those in the clerical category. It is assumed that current economic conditions are contributing to that situation.

Table 19, as provided by the Employment Security Division, provides a more current estimate of the potential labor supply in the Southeast Arkansas area. These statistics represent both the employed and unemployed, as of February 29, 1980.

However, the recent public announcement that a multi-million dollar plant at Camden to produce defense weapons for the military is likely to create major changes in the potential labor supply. Although it will be within 30 miles of the proposed lignite mining operation near Hampton, it is expected to employ as many people as both the mining and power production facilities at Hampton.

In view of that anticipated big labor demand by the Camden plant, it is expected that the mining and power plant operation at Hampton must draw more heavily on the available labor supply in the Warren area, thereby increasing employment opportunities for VO-Tech graduates from the Warren Center.

Estimated Potential Labor Supply

Experienced Workers By Occupational Category

Residing Within A 30 Mile Raduis

Table No. 7

Occupational Category	Warren		Rison		Fordyce		Camden		Monticello		Eldorado	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Professional, Technical, and Managerial	31	32	73	74	36	40	65	70	38	41	52	59
Clerical and Sales	40	149	103	410	36	177	62	297	60	175	52	245
Services	39	144	92	396	41	165	67	289	51	181	53	244
Processing	15	8	20	11	15	8	40	40	15	8	38	44
Machine Trades	77	38	122	43	90	26	121	25	77	40	94	22
Benchwork	17	73	34	137	18	123	25	172	24	89	20	127
Structural Work	136	6	282	137	135	4	206	11	168	10	176	12
187											188	

Source: Arkansas Employment Security Division

Preliminary Labor Force Estimates by Counties

June 1979

Table No. 8

	Ashley	Bradley	Calhoun	Cleveland	Dallas	Desha	Drew	Lincoln	Ouachita	Union
Civilian Labor Force	10,900	5,975	2,075	2,075	4,350	7,925	8,300	3,900	12,075	24,000
Unemployment Rate	5.7	6.3	6.0	7.2	5.7	5.4	6.0	5.1	7.9	5.0
Total Employment	10,275	5,600	1,950	1,925	4,100	7,500	7,800	3,700	11,125	22,800

Source: Arkansas Business and Economic Review, Fall 1979

Warren Area - Bradley County

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 9

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	70	14	56	15
Forestry Occupations	11	11	0	4
Machine Trades	16	11	5	7
Electrical Work	4	2	2	3
Carpentry	24	22	2	7
Structural Work	25	23	2	3
Mining	2	2	0	1

Source: Arkansas Employment Security Division

Fordyce Area - Dallas County

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 10

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	55	14	41	13
Forestry Occupations	16	16	0	12
Machine Trades	31	28	3	6
Electrical Work	8	7	1	3
Carpentry	30	30	0	13
Structural Work	19	19	0	7
Mining	1	1	0	0

Source: Arkansas Employment Security Division

Rison Area - Cleveland County

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 11

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	35	2	33	2
Forestry Occupations	6	6	0	3
Machine Trades	20	13	7	0
Electrical Work	3	3	0	0
Carpentry	8	7	1	1
Structural Work	16	16	0	4
Mining	0	0	0	0

Source: Arkansas Employment Security Division

Camden Area - Calhoun and Ouachita Counties

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 12

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	219	25	194	82
Forestry Occupations	16	16	0	7
Machine Trades	74	64	10	33
Electrical Work	129	107	5	81
Carpentry	96	92	4	46
Structural Work	76	72	4	21
Mining	0	0	0	0

Source: Arkansas Employment Security Division

Monticello Area - Drew County

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 13

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	146	27	119	30
Forestry Occupations	51	24	27	16
Machine Trades	51	38	13	19
Electrical Work	23	14	9	5
Carpentry	50	49	1	11
Structural Work	79	75	4	24
Mining	0	0	0	0

Source: Arkansas Employment Security Division

Star City Area - Lincoln County

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 14

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	66	9	57	28
Forestry Occupations	5	5	0	3
Machine Trades	17	15	2	4
Electrical Work	4	1	3	3
Carpentry	40	38	2	22
Structural Work	27	25	2	14
Mining	0	0	0	0

Source: Arkansas Employment Security Division

McGhee Area - Desha County

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 15

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	71	18	53	30
Forestry Occupations	3	3	0	2
Machine Trades	34	27	7	18
Electrical Work	42	22	20	26
Carpentry	45	44	1	24
Structural Work	46	46	0	33
Mining	0	0	0	0

Source: Arkansas Employment Security Division

Dermott Area - Chicot County

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 16

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	74	18	56	50
Forestry Occupations	4	3	1	1
Machine Trades	42	42	0	25
Electrical Work	11	9	2	7
Carpentry	70	67	3	58
Structural Work	42	41	1	21
Mining	2	2	0	0

Source: Arkansas Employment Security Division

Eldorado Area - Union County

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 17

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	289	30	259	76
Forestry Occupations	6	6	0	6
Machine Trades	111	94	17	39
Electrical Work	39	17	22	17
Carpentry	114	110	4	39
Structural Work	85	71	14	28
Mining	0	0	0	0

Source: Arkansas Employment Security Division

All Southeast Arkansas Counties
Bradley, Dallas, Cleveland, Calhoun, Quchita, Drew
Lincoln, Union, Desha, and Chicot

Occupations of Job Applicants On File With Arkansas Employment Security

By Sex and Minority Status, March 31, 1979

Table No. 18

Occupational Category	Total Number	Male	Female	Minority
Clerical Occupations	1025	157	868	326
Forestry Occupations	118	90	28	54
Machine Trades	396	332	64	151
Electrical Work	263	182	55	155
Carpentry	477	459	18	221
Structural Work	415	388	27	158
Mining	5	5	0	1

Source: Arkansas Employment Security Division

Estimated Potential Labor Supply

Experienced Workers By Occupational Category

Residing Within A Thirty Mile Raduis

February 29, 1980

Table No. 19

Occupational Category	Warren		Fordyce		Rison		Camden		Monticello		Eldorado		McGhee		Star City	
	M*	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Clerical and Sales	40	149	36	177	103	410	62	297	60	175	52	245	49	126	114	419
Services	39	144	41	165	92	396	67	288	51	181	53	244	42	126	97	412
Processing	15	8	15	8	20	11	40	40	15	8	38	44	12	5	22	12
Machine Trades	77	38	90	26	122	43	121	25	77	40	94	22	50	23	111	49
Benchwork	17	73	18	123	34	137	25	172	24	89	20	127	18	63	34	125
Structural Work	136	6	135	4	282	8	206	11	168	10	176	12	121	9	301	12

Source: Employment Security Division

* M represents Male - F represents Female

Business and Industrial Growth

in

Mt. Pleasant, Texas

Since Development of Lignite Mining

Beginning with approximately 9,459 in 1973, the population of Mt. Pleasant has grown to 15,000 during that period. Per capita income figures were not available. Its total business and industrial growth has almost doubled, as can be noted in Table 20 .

For this tabulation, comparative figures were taken from telephone directory listings in 1970 and 1979.

In comparison, the current population of Warren is 7,031, while its current per capita income is approximately $ 5,000, according to the local chamber of commerce.

While Mt. Pleasant has experienced a relatively more favorable economy and also has enjoyed a location much closer to the mining operation, it is anticipated the business and industrial growth of Warren will be quite similar. The mining operation at Mt. Pleasant is located within 2 or 3 miles of the city. Warren is located within approximately 30 miles.

It can be noted from the telephone directory listings that the greatest growth percentage wise has been in building contractors, general contractors, machine shops, electric motor repair shops, heating and air conditioning repairment, radio and communications equipment, and farm equipment suppliers.

This implies a need at the Warren Area Vo-Tech Center for giving greater emphasis to more training in these areas in the next few years, in order to meet the anticipated requirements in normal expansion. This is to be over and beyond the needs of the lignite mining and power industries.

Growth of Mt. Pleasant V0-Tech Program

VS

Potential for warren Vo-Tech Program

The Warren Area Vo-Tech Administrator and Research Directors visited the Mt. Pleasant Area Vo-Tech Center in March of this year. In May they held a conference by telephone with the Mt. Pleasant Vo-Tech administrative staff. It was determined that the Mt. Pleasant Vo-Tech program has tripled in size since the lignite mining began in 1973. See Table 20.

While the high school enrollment grew from 900 to 1160, total vocational enrollment increased from 160 to 807. Of these, 264 were juniors and seniors in vo-tech training. At Warren, the high school enrollment is 611, while the total vocational enrollment is 411. There are 113 Warren students in vo-tech training. See Table 3.

The vocational courses offered at Mt. Pleasant have been increased from 8 to 25, some of which are at the Junior High level. Determination of the courses offered was done by community survey, consultation with parents and students, and by help from advisory committees.

Prior to the lignite mining development, there were 7 small local business and industrial establishments who offered some employment opportunities to trainees. Also, there were large employers like Lone Star Steel Company at Lone Star, Schlitz Brewery at Longview, and Campbell Soup Company at Paris, Texas, all within a 50 mile radius. Since that time, the number of

local business and industrial establishments has grown from 7 to 14, offering many and varied employment opportunities.

In comparison Warren, with about half the population of Mt. Pleasant, has 4 small local manufacturing establishments and a major one - the Potlatch Corporation. Within 30 miles of Warren is also the Georgia Pacific Plywood Mill at Fordyce.

The potential for industrial development in the Warren area compares favorably with that of Mt. Pleasant before the lignite mining started there.

Before expansion in technical training started at Mt. Pleasant in 1973, their vo-tech program consisted of Auto Mechanics, principally. Since that time they have gradually added to their curriculum courses in Building Trades, Air Conditioning/Refrigeration, Electrical Trades, and Metal Trades. Later, cosmetology and Printing were added.

Both the teachers and administrative staff maintained a good working relationship with local employers and were able to place most of their trainees in employment. Currently, there is reported to be little difficulty in finding employment for the Mt. Pleasant Vo-Tech trainees, who desire it.

It was revealed by the Mt. Pleasant administrative staff that the lignite mining employers really preferred more mature employees who were more likely to seek a career in that industry. However, other employers had not shown that preference.

Comparison of Cities
Mt. Pleasant, Texas vs Warren, Arkansas

Table 20

Business or Service	Mt. Pleasant		Warren
	1970	1979	1980
Electrical Contractors	4	7	3
Electrical Equipment & Supplies	2	3	2
Electric Motor Repair Shops	1	3	1
Heating & Air Condition Repairs	7	15	3
Heating & Air Conditioning Contractors	7	9	3
Refrigerator & Freezer Services	4	7	2
Welding Shops	6	10	1
Machine Shops	1	3	2
Auto Repair Shops	22	33	13
Auto Parts and Supplies	3	5	13
Small Engine Repair	6	9	2
Wrecker Service	4	5	3
Building Contractors	1	9	1
Building Materials Supplies	4	8	2
Plumbing Contractors	5	7	4
Concrete Contractors	3	3	1
General Contractors	6	22	4
Cabinet Makers	0	1	1
Clinics, Physicians	4	8	4
Radio & Communication Equipment	2	4	2
Data Processing Services	1	1	0
Farm Equipment Suppliers	4	11	6

Source: Mt. Pleasant & Warren Telephone Directories

Work Force Requirements

Lignite Mining (Sparta Mine)

and

Electric Power Production

In Tables 21, 22 and 23 the Sparta Mine management and the Arkansas Power and Light Company have listed their labor requirements for both the Construction and operation of the facilities planned for the Hampton Area. They estimated construction to begin in 1985. It is revealed that the peak work force will be needed during third and fourth year of construction at the power generating plant. That information is not available for the mine construction job.

An Analysis of the work force needs for construction at both facilities, reveals their major needs as follows:

Building Technicians	252
Electricians	278
Millwrights	155
Operating Engineers	216
Steam Fitters and Plumbers	510
Ironworkers	297
Sheet Metal Workers	103
Truck Drivers	86
Painters	47

It is noted here that during construction the greatest need will be for Steam Fitters and Plumbers, then comes iron workers

and operating engineers. Neither Vo-Tech school in Southern Arkansas offers training in these trades. Since the construction period is relatively short, it isn't economical to set up and staff for such training.

But, both the Secondary and Post Secondary schools are equipped and staffed to train students in Building and Electrical Trades. These will be next in demand. The Vo-Tech schools should give greater emphasis to this training. Growing local industries will absorb them later.

An anylsis of the work force needs for operation at both facilities, reveals the major needs for this category as follows:

Electricians	93	
Mechanics	136	(Sparta Mine)
Equipment Operators	220	
Dragline Operators	56	(Sparta Mine)
Truck Drivers	55	(Sparta Mine)
Plant Repairmen	65	(A P & L)
Secretarial and Clerical	20	
Instrument Technicians	23	(A P & L)

Neither the Warren Area Vo-Tech Center nor other Vo-Tech schools are staffed to train dragline operators, truck drivers, equipment operators, plant repairmen and instrument technicians. But they are set up to train electricians and mechanics. Greater emphasis should be given to training the latter in support of the new lignite and power production industry.

SPARTA MINE
WORK FORCE REQUIREMENTS

Table 21

1. CONSTRUCTION

Brick Mason	4
Carpenter	60
Cement Finisher	8
Electrician	48
Equipment Mechanic	5
Field Engineer	11
Instruments	4
Laborer	68
Millwright	75
Operator-Equipment	41
Painter	2
Pile Driver	10
Pipe Fitter	5
Pipe Welder	2
Plumber	3
Rebar	20
Sheet Metal	3
Structural Iron	67
Supervision	43
Truck Drivers	21

2. MINE OPERATION

A. Hourly Personnel

Belt Operator	20
Dozer Operator	60
Dragline Operator	56
Electrician	65
Front Endloader Operator	15
Laborer	40
Mechanic	136
Miscellaneous Equipment	10
Motor Grader Operator	10
Scraper Operator	35
Truck Driver (Highway Truck)	15
Truck Driver (Off-Highway Truck)	40

B. Salary Personnel

Draftsman	2
Electrician Foreman	2
First Aid & Safety	5
Junior Accountant	2
Laboratory Technician	2
Mechanic Foreman	2
Pit Foreman	7
Plant Foreman	1
Relief Foreman	2
Rodman	2
Secretarial & Clerk	15
Shop Foreman	2
Surveyor	2
Training Specialist	3

Arkansas Power and Light Company - Lignite Project
Peak Construction Work Force Requirements, By Years

Table No. 22

Craft	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year
Boilermakers	30	240	350	445	300	205
Bricklayers	0	5	15	5	10	0
Carpenters	100	150	170	180	80	30
Cement Finishers	5	20	20	20	10	5
Electricians	15	200	230	210	150	120
Insulators	0	20	70	40	50	20
Ironworkers	130	250	230	180	100	15
Laborers	160	370	315	255	120	80
Millwrights	0	50	80	40	60	20
Operating Engineers	150	175	150	140	80	60
Painters	10	35	45	65	40	30
Pile Drivers	15	0	0	0	0	0
Roofers	0	10	5	5	5	0
Sheetmetal Workers	0	20	100	100	70	30
Sprinkler Fitters	0	10	20	45	15	20
Steamfitters and Plumbers	300	350	500	410	300	100
Teamsters	45	45	60	65	25	15
Totals	960	1,950	2,360	2,205	1,415	750

White Bluff S.E.S.
Operations Personnel

Table No. 23

Position	No. Personnel
Plant Manager	1
Planning & Scheduling Coordinator	1
Secretary to the Plant Manager	1
Operations & Maintenance Manager	1
Plant Administration Manager	1
Plant Engineering Supervisor	1
Support Engineers	6
Plant Performance Engineers	1
Chemical & Environmental Supervisor	2
Plant Chemist	1
Clerk Chemist	5
Operations Superintendent	1
Assistant Operations Superintendent	1
Shift Supervisors	10
Plant Operators	4
Assistant Plant Operators	8
Boiler Operators	8
Auxiliary Operators	20
Helpers (Operations)	16
Stacker/Reclaimer Operators	4
Car Dump Operators	4
Dozer Operators	8

Operations Personnel (Cont.)

Position	No. Personnel
Ash Equipment Operators	4
Coal Yard Utility Operator	8
Coal Yard Workers	8
I & C Superintendent	1
I & C Supervisors	2
Sr. Instrument Technician	1
Instrument Technicians	11
Instrument Technician Helpers	12
Maintenance Superintendent	1
Maintenance Supervisors	8
Machinist Repairman	1
Plant Repairman	33
Plant Repairman Helpers	32
Sr. Plant Maintenance Electrician	1
Plant Maintenance Electrician	14
Plant Maintenance Electrician Helper	14
Materials Management Supervisor	1
Stores Supervisor	1
Purchasing & Expediting Coordinator	1
Storekeepers	5
Human Resources Supervisor	1
Employment Coordinator	1
Training Supervisor	1
Training Coordinators	2
Fuel Management Supervisor	1
Office Services Supervisor	1
Clerk Typist & Clerks	5

Source: Arkansas Power & Light Company